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**BULLETIN No. 19**

## **Production of Grass Seed**

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**ABERYSTWYTH, JUNE, 1937.**



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# HERBAGE PUBLICATION SERIES

BULLETIN 19

## PRODUCTION OF GRASS SEED

An international exchange of opinions and experiences on the technique  
of producing seed of Gramineous herbage and forage plants

Edited by

R. O. WHYTE



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THE cultivation of ryegrass for seed was introduced into Ireland in the early years of the nineteenth century by immigrant farmers from the south-west of Scotland—the chief centre then, as now, of the industry in Great Britain. In the course of the century the daughter business outdistanced the parent; to-day the north-eastern counties of Ireland produce annually twice or thrice as much ryegrass seed as does Scotland—a bulk varying from 20 to 25 thousand tons—and form in fact the most productive world centre of the industry.

There is much in common between a seed crop of ryegrass, especially Italian (*Lolium multiflorum*), and a cereal such as oats. The essential differences in treatment in the case of perennial arise not from any innate dissimilarity between the crops in their harvest year, but from the fact that for economic reasons perennial ryegrass (*L. perenne*) is retained for other purposes for several seasons after the seed has been harvested. Tentative trials suggest that perennial ryegrass could, if there were any commercial advantage, be treated as a cereal—even as a spring-sown cereal—in this district.

Under present standard practice the seed crop is broadcast by hand or fiddle in spring (April) under a nurse crop of oats or flax with, in the case of perennial, a mixture of other grasses and clovers designed for a three or four-year's ley. Nominally the second, third and fourth years of such a ley are pasture years, but in practice a second hay crop is sometimes taken. A second seed crop is not attempted, though light seed crops are often harvested in good years from mixtures intended, when sown, for hay and pasture only. Italian ryegrass is sometimes sown in August, without a nurse crop, following an early potato crop. A typical (and successful) mixture for perennial seed production is:

|                                                  | lb. per statute acre. |
|--------------------------------------------------|-----------------------|
| <i>Lolium perenne</i> .....                      | 40                    |
| <i>Dactylis glomerata</i> .....                  | 8                     |
| <i>Phleum pratense</i> .....                     | 4                     |
| <i>Trifolium pratense</i> (late-flowering) ..... | (none or) 2           |
| <i>T. repens</i> (wild white) .....              | 1                     |

Care must be taken not to sow too much of the larger clovers, and in those districts where they succeed specially well, none is used.

For Italian ryegrass the seeding is 2 bushels (= 44 lb.) per acre, without any other grasses or clovers.

The question of optimum climatic conditions is somewhat involved. For vegetative growth ryegrass demands a cool and moist season. For thorough ripening, sun is obviously essential. Thus a "dropping" spring and early summer, a fine spell in June for pollination, gentle rain during the filling of the grain and a further fine period in July for ripening would seem to be the theoretical optimum. In Northern Ireland, these conditions are seldom attained in full. But apparently sub-optimal conditions are not without advantages. Under fine, dry, summer weather perennial and Italian appear to cross more readily than under relatively less "suitable" conditions. In practice, inter-crossing in the field seems a negligible factor. Average Irish commercial ryegrass shows a percentage of fluorescence reactors approximating to ten (only a part being due to hybrids and segregants) and this proportion does not appear to increase. Italian ryegrass normally flowers some ten to fourteen days later than perennial, too, but there is nevertheless considerable over-lapping between the advance-guard of Italian and the rear-guard of perennial crops; the flowering period of each species for the country as a whole extends over about a fortnight.



The degree to which the grass develops in the "foot" of the nurse crop depends upon a combination of factors, notably strain of ryegrass, species and variety of nurse, manuring, and character of season. As too great a development of the grass is not desirable on account of harvesting difficulties, manure is usually not applied at this stage. A dressing of one cwt. sulphate of ammonia is sometimes applied to a perennial crop in the spring of the grass-seed harvest year; for Italian this dressing is usual. No special cultivations are used; the young ley is lightly grazed by young stock in the autumn of the seeding year, and rolled in the spring of its harvest year, when it may be grazed again according to condition and amount of winter growth.

The period of growth of a ryegrass crop is about 64 weeks, of which the first 15 to 18 are spent under the nurse crop. Perennial ryegrass flowers in mid-June and comes to harvest in the middle of July; Italian is a couple of weeks later. Uniformity of ripening is good compared with some grasses (such as *Alopecurus pratensis*), but judgment of the precise moment for cutting to obtain the maximum yield of optimum quality is nevertheless a matter of great nicety. This applies to all ryegrass crops, but particularly to mixtures of perennial and Italian for the obvious reason that the two species do not ripen their main bulks at the same time. In "pure" crops this difficulty is not present, but all the seeds of a head, all the heads of a plant, and all the plants of a community naturally do not ripen quite together. The trade view is in favour of thorough ripening—*over* rather than *under* being preferred, but this is probably referable to the long tradition of assessing grass seed quality by bushel weight—a misleading criterion which legislation has tended to perpetuate.

In experiments in Northern Ireland perennial seed harvested ten or fourteen days before normal ripeness, and weighing very much less than the standard for fully-developed seed of 28 lb. per bushel, germinated at least as well as the latter, and when sown under farm conditions produced a crop equally good in all respects. Against this it must be observed that the last process in ripening is desiccation, and neither grower nor buyer wishes to pay heavy freight charges on superfluous water, especially where the major part of the trade is in exported seed. Moreover, moist seed does not store as well as the drier product, and it is much more liable to suffer deterioration in vitality during shipment through the tropics. Ripeness in the field may be judged by grasping a bunch of heads lightly in the hand without pulling or crushing, when a few seeds will be left in the palm; or the heads may be swept with a cap or hat, when again a few seeds will be detached and collected. At this stage the kernel is honey-coloured, firm but not hard, and the straw below the ear is still grey-green or silvery. Italian ryegrass shatters a little more easily than perennial when ripe, but unless over-ripe neither is very troublesome in this respect. Care must nevertheless be exercised in handling sheaves after they have finished ripening in stook, where they remain some fortnight or three weeks before building into small ricks or pikes. For salvation of shattered seed as well as for protection against weather, these "ricks" are built with the butts of the sheaves outwards. Each contains about a quarter of a ton of hay and remains in the field for a variable period of six or eight weeks, according to weather and convenience. Threshing (by travelling mill) is usually completed by the end of November and seed not marketed at once is stored until spring in dry, airy lofts.

Ryegrass crops are mercifully free from insect and fungoid pests. Traces of ergot (*Claviceps*) are not uncommon but are inconsiderable and such sclerotia as may be threshed are usually completely removed by machining.

An average perennial crop will multiply its seed some sixteen times, yielding 5 to 6 cwt. of clean grain per acre; a heavy crop may produce over 7 cwt. Italian ryegrass yields are somewhat greater, averaging about 6 cwt., and sometimes reach-



ing over 8. The seed is roughly cleaned on the farm and may be expected at this stage to show an analytical purity of about 85 to 90 per cent. Sale is usually effected through the medium of local markets where representatives of wholesale ryegrass machiners are in attendance during the autumn and winter months. Final cleaning is carried out by merchants, and samples of the finished product may be expected to be over 97 per cent pure. The commonest impurities are traces of *Holcus lanatus*, *Festuca scurroides* and *Bromus mollis*. The laboratory germination naturally varies from year to year; during the ten seasons 1924-34 the average modal figure was 87 per cent, but reached 97 per cent in season 1934-35. Wholesale prices to the grower are extremely unstable and from season to season may vary between such wide limits as 9s. and 25s. per cwt.

**Perennial Ryegrass  
(*Lolium perenne*)**

**J. W. PALMER**

**New Zealand  
(North Island)**

SEED production is confined to districts of somewhat low rainfall, that is, from 25 to 40 inches, provinces with a rainfall of 30 inches average being most favoured. Hawke's Bay, Poverty Bay and Wairarapa are probably the most suited, while the Manawatu, with a somewhat higher rainfall, produces good seed in certain belts furthest from the main ranges, such as the Sandon district. Although Hawke's Bay and Poverty Bay are mentioned as being suitable for seed production, it must be pointed out that the whole of these Provinces are not suited, certain localities, particularly the Plains and certain portions of the fertile flats of the Central districts, being far more favourable for seed production.

Seed production is considered only as a secondary industry to the production of fat lambs, grazing, or even dairying. It is only after the early lambs have gone that areas are closed for the harvesting of seed. It would be to the great advantage of the seed industry if it were viewed more as the primary consideration as in the South Island. However, the quality of seed produced is of a very high standard and the crop serves as an additional revenue for the farmers of these districts.

**SOIL TYPES.**

The soil on which most of our seed is produced varies from a heavy loam to heavy alluvial silts. These soils retain moisture and favour even maturing of the crop after the dry weather commences. Other soils used for seed production are those of the pumice showers and peaty nature, while, in some instances, a heavy clay or even papa clay may be used. On the pumice and peaty soils an unevenness in the crop is often experienced.

**ROTATION.**

Generally speaking, no rotation is practised on areas which are being prepared for the sowing down of perennial ryegrass. Usually a field which has run out and requires resowing is ploughed in the autumn and sown down immediately. In some cases a crop such as oats or barley may be sown and this may be followed by rape (only in a few instances is this the case). In the following autumn the field is re-sown. In portions of the Poverty Bay flats, maize or pumpkins may be sown and harvested for two or three seasons, when the area will be sown to grass. In the Wairarapa Province a swede, chou moellier, rape or sometimes a cereal crop, such as barley or oats for chaff, may be first grown and grass sown after a season or two. In the

majority of cases, however, rotation is seldom practised, the main object being to bring the area back to grass as soon as possible in order to harvest the area for seed. This practice often results in dirty areas which would have been greatly improved if some fallowing or rotation had been practised.

#### SOWING METHOD.

Usually the seed is broadcast through a manure distributor or even with a broadcast attachment on the drill ; in some few instances the seed is mixed with the manure and broadcast. On the heavy fertile flats the practice of sowing manure is very seldom followed, while on some of the lighter soils 2 to 3 cwt. superphosphate per acre is applied. Preference is sometimes given to the practice of making a later application of superphosphate, preferably ammoniated superphosphate, to the young pasture during July or August. This speeds up the grass growth for early lambing and maximum grass production is obtained from the area prior to the closing for seed.

The seed rate varies from 1.5 to 3 bushels per acre. Good swards have been established from sowing 1 bushel of ryegrass, but, on the other hand, where weeds are likely to prove troublesome 2 and even 3 bushels are sown. Most areas are sown with machine-dressed seed with a purity of at least 95 per cent.

#### NURSE CROPS.

Nurse crops are seldom used with grass seed ; occasionally a bushel of oats may be sown, but this is not common.

#### TIME OF SOWING.

Sowing is usually done after the autumn rains, sometime in March. In some instances, seed may not be sown until the end of May, but this is somewhat late, although quite satisfactory stands may be established. The later cannot be compared with the earlier sowing.

Cultivation of the ground usually takes place after the autumn rains, when a deep ploughing of about 6 inches is made. Sometimes the furrows are rolled down, and a subsequent disking is carried out to prepare a fine seed bed. The ground is finally harrowed, rolled, the seed broadcast, and the ground re-harrowed and rolled.

With the early sowing in March, grazing can be lightly done at the end of May, with light grazing during the winter months being preferable. During August, September and onwards increased stocking is exercised to cope with the growth of pastures, areas sometimes carrying as many as 20 sheep to the acre to control the spring growth. Areas, as a rule, are grazed hard prior to closing, which usually occurs in mid-October on the average soil ; on the heavier, wetter areas the fields are not closed until November, while on the light pumice showers, or even soils of a peaty nature, areas may be closed as early as the first week in October.

The crops generally are very uniform and even and, after mid-December, the seed heads are well-filled and quickly turn to a bronzy colour. When the first two or three seeds at the tip of the heads fall, or when a hat is swung through the standing crop gathering enough seed to half-fill an egg cup, one may consider the crop suitable for cutting. At this stage the remainder of the seed may not be quite ready to shed but there is sufficient sap retained in the stalks finally to ripen the seed during harvesting.

#### METHOD OF HARVESTING.

Methods vary considerably according to the implements of the farmers.

In some instances the reaper and binder is used, the crop being stooked until the final drying has taken place. Others use the ordinary horse-mower and the crop is



immediately raked and cocked and left to lie in the field until maturity. A side-delivery mower has proved quite a good method as the crop is delivered to the side of the machine in little heaps, thus saving raking and cocking. The use of the combined headers is not in vogue here, while the stripper is used only on light crops where the bottom growth has been eaten out by stock, leaving the seed heads. The stripped seed is put into half-bags, hung along the fence line to dry, and finally bagged. Since the introduction of the International harvester in the district the crop is cut and raked into windrows to dry for about a week or ten days; then the machine travels along picking up the windrows and threshing the crop as it goes. The threshed straw is returned to the field, together with a considerable amount of weed seeds. This is all later raked and stacked. It is yet too early to pass any comments on the effect of returning the weed seeds to the pastures.

Other methods of harvesting include the collecting of cocks and stacking to allow sweating to take place, later threshing out from the stack to obtain clover seeds; threshing out of the field after the cocks have remained for ten days or more in the field but not for any set time. This practice is dependent upon the time that the mills are available for threshing and has frequently proved disastrous, many crops being spoilt by constant wetting and turning under adverse weather conditions.

The farmer-cleaned seed is usually forwarded to the merchants with cleaning stations, and is there brought to the purity necessary for certified seed. In these districts the majority of perennial ryegrass is harvested under the Government certification system—the proportion of Government certified seed to uncertified seed is probably 80 to 20 per cent.

Some areas may be harvested for two or three years in succession. This practice is not considered the best, especially where light grazing is practised, as these areas become badly infested with certain weeds. If an area is top-dressed and heavily stocked, it may be harvested for two years in succession with quite profitable returns.

Occasionally rust attacks the crops, particularly if wet conditions are experienced and they become lodged, but the upright crops are seldom affected. A caterpillar may attack some crops, not only before cutting, but also after the seed has been cocked; on occasion the whole crop has been destroyed by caterpillars.

In summarizing the methods adopted for seed production in various districts, one would say that a good crop of seed depends solely upon the management of the area which has to be harvested. The different methods of harvesting actually play no part as far as the maximum of seed per acre is concerned. An area sown in the early autumn, top-dressed at time of sowing, stocked lightly at first, and more heavily as the crop becomes well established in order to prevent rank growth and the smothering of pasture plants, will give the best results.

Should a crop be taken from a newly-sown area, it is absolutely essential to top-dress in the following autumn, with good stocking and grazing in the second season to enable undesirable annuals to be controlled. In this way, the third year crop will be as heavy as in the first year, or even heavier, and little or no harm will result in the sward.

Stacking of the seed crop after cutting and drying is the most favourable, as it obviates the risk of damage from wind and rain. Once the seed is in the stack and is well covered, it can remain there until it is convenient to thresh. Hundreds of bushels of seed may be lost through neglect in harvesting and also in badly-covered stacks.

A good crop of first-harvest seed produces about 50 to 60 bushels per acre. Crops have been known to yield 80 bushels per acre, which has brought in the vicinity of 5s. per bushel. Returns from areas properly sown and well-managed give quite a good revenue to the farmer, particularly when ryegrass seed production is regarded as a secondary consideration to lamb and mutton production.

PERENNIAL ryegrass is the basis of the major portion of the mixture used in the sown pastures in New Zealand. Over 70 per cent of the seed produced comes from the two agricultural provinces of the South Island, Southland and Canterbury. These provinces are also the Dominion's chief producers of cereal crops. It would appear therefore that, within New Zealand, areas suitable for the production of wheat, oats and barley are also suitable for the production of perennial ryegrass seed. On account of the favourable climatic conditions, these districts produce heavy, bright, clean seed, attractive to the eye and keenly sought after by the trade. While this is true, however, it has been proved by the Department of Agriculture that the methods of producing seed adopted by the farmers of these two provinces, without the provision of high-class stock seed, and in the absence of any means of ensuring that the seed produced has not deteriorated, lead to the production of inferior and mixed strains totally unsuitable for the real economic purpose of any pasture seed, namely, that of producing leaf.

With the introduction of certification and consequent supervision of seed-producing areas, the methods adopted up to the present would suffice to maintain the present production. These methods are, however, dependent on good seasons. At present, if weather conditions are favourable, the seed production is high. This holds good even where seed production is the primary consideration, but in Canterbury, especially, perennial ryegrass seed is a secondary consideration. The production, therefore, fluctuates even more. Canterbury farmers are essentially cereal growers and sheep graziers. In a good season the surplus grass crop is used for perennial ryegrass seed production, little or no hay or ensilage being saved. From this it will be seen that the seasonal variation is greater than if seed production was the primary consideration.

The method adopted generally is to sow down a simple mixture such as 20 to 30 lb. perennial ryegrass and 4 lb. of red clover under wheat or oats in spring, or with turnips or rape in November and December. In the following season the field is grazed up to October and then allowed to go to seed; the majority of the seed produced comes from these first-year fields. Only when an extremely favourable spring has been experienced are older fields saved for seed, as under the normal conditions the quantity of seed produced is not profitable. Yields average about 20 bushels of machine-dressed seed per acre.

The rainfall in these districts ranges from 20 to 30 inches, but the main factor is dry conditions at the maturing and harvesting stages. The soil type varies considerably from heavy clay loam through silts to light stony areas.

Harvesting is done in various ways. Where the crop is good, it is cut and tied with a reaper and binder, stooked and allowed to stand for 10 to 14 days and then threshed. Where the crop is poor, stripping is carried out. For this purpose, the crop is allowed to become much riper than for the previous method. It is then stripped either by a chain drum or a batten stripper. The seed is bagged in open-mesh bags, hung on wire fences and allowed to mature. The bags are only half-filled to allow free circulation of air to mature the seed.

The other method and modification of it which have come into vogue recently is the use of the header harvester. On dry, quick-maturing country such as Ashburton Plains direct heading is carried out, and the seed bagged as in the stripping method. Where conditions are not so suitable or if it is preferred, an alternative method of cutting with the binder from which the binding gear is detached, that is, windrowing the crop, and then picking it up and threshing with the header ten days later, can



be adopted. This method can be improved for large areas by using two binders in cutting, a 6 ft. and 10 ft. machine. The 6 ft. machine delivers the cut material direct from the platform canvas to the ground. The 10 ft. binder carries the material up the elevating canvases, and through usual channels, but does not tie it. The result is two windrows, 2 ft. apart, which can be handled by the pick-up attached on the header. This speeds up the threshing with the header, as it can now deal with 16 ft. of crop. The disadvantage of this method is that, where a heavy rain or thunderstorm is experienced, the seed is beaten out of the windrowed crop on to the ground, whereas when the crop is stooked the seed is forced into the bands of the sheaves. Further, if unsuitable harvesting conditions are experienced, and the crop has to lie for any length of time, it is often buried by the new growth.

There is no doubt that the old method of reaping, binding and threshing is still the surest means of dealing with the crop. The majority of crops are stook-threshed, as in the stacking the extra handling causes a good deal of waste.

The average dressing loss is about 20 per cent and seed weighing 28 to 30 lb. to the bushel with a germination of 90 to 98 per cent and a purity of 97 to 99 per cent is most desired.

The production of Government certified perennial ryegrass in Canterbury and Southland is now being carried on from seed grown in Hawke's Bay. Results have shown that under a competent system of certification the seed thus produced under short-rotation conditions in these districts will not deteriorate in strain.

It has been found that the seed produced from true perennial ryegrass in Southland is liable to show poor germinating capacity. This has been attributed to the presence of a fungus which invades the developing seed. No definite knowledge is available in regard to this fungus, the effect of which appears to be harmful only when more humid seasonal conditions prevail.

There is no doubt that the system of farming in the ryegrass seed producing areas without adequate supervision has produced an inferior hybrid perennial ryegrass, but it must be clearly understood that perennial ryegrass seed production in New Zealand is undergoing a big change. The methods used for harvesting will remain the same, but perennial ryegrass will be increasingly grown for seed production alone and not as in the past, more or less haphazardly. Under the Department of Agriculture's certification scheme only high-class seed is produced, and this is rapidly making the poorer type unsaleable.

### Italian Ryegrass (*Lolium multiflorum*)

J. G. MCKAY

New Zealand

As a pasture plant in New Zealand, Italian ryegrass finds a place mainly in localities where short-rotation farming is practised. It is used to some extent as a constituent of pasture mixtures for semi-permanent leys or haying crops, but is more widely grown to provide autumn and winter grazing for stock.

As a result of saving seed from hybrid strains, a condition brought about through cross-pollination of Italian and perennial ryegrass in association, some extremely low-producing types of Italian ryegrass were being produced locally, but with the introduction of a seed certification scheme for Italian ryegrass, together with the importation of pure and high-producing strains from overseas, a considerable improvement in this direction has now been effected.

## ROTATION.

Italian ryegrass is grown on a wide range of soils, with a rainfall average of from 24 to 35 inches per annum, and in the rotation may be sown on land fallowed for eradication of weeds, or following an early harvested cereal crop where the best results can be expected only if ploughing and subsequent cultivation are begun as soon as the grain crop is removed.

## SOWING METHOD.

The seed may be sown either broadcast or drilled-in lightly through every coulter of the grain drill. Where the former method is adopted a good seed bed is essential, and in obtaining this a system of fallow with periodical cultivations is of distinct benefit. If the land is well-prepared and there is sufficient moisture in the top soil, broadcasting is unquestionably an excellent method of sowing, as a better distribution of plants is obtained in this way than by drilling. On the heavier soils where the crop is grown specifically for seed production purposes, the broadcast method is adopted by a number of farmers; if the land is in good heart such areas are at times sown without fertilizers, in which case it is customary to topdress when the plants are more or less established. Insufficient time in which to prepare a suitable seed bed and lack of moisture in the surface soil are, however, factors which often militate against rapid establishment by broadcasting, and the more general method is to sow lightly through every coulter of the drill, the best distribution being obtained if the seed is drilled and cross-drilled, sowing half the total amount required each way.

Drilling enables fertilizers to be applied with the seed; where sowings require to be delayed until late autumn, as is frequently the case, fertilizers thus applied assist in rapid establishment of the plants.

## RATE OF SEEDING.

In sowing ryegrass alone, seedings average about 30 lb. per acre, slightly less when sown in combination with a cereal such as Algerian oats. The Algerian oats-Italian ryegrass combination is sown usually when the production of green feed for sheep or cattle is the main objective; but if not required for late spring grazing, areas sown with this mixture are at times harvested for seed.

## NURSE CROP.

For late autumn sowings, where a nurse crop is desirable as a protection against frost, Algerian oats at the rate of 1 bushel or slightly less per acre are used almost invariably. They are winter hardy and, besides providing protection for the young grass plants, will under favourable conditions produce much winter grazing.

## TIME OF SOWING.

Sowings may take place at any time during February, March and April. Occasional areas are sown early in May but there are few localities or seasons in which the grass will establish well or produce much winter grazing if sown later than the end of April.

## MANURING.

The chief fertilizers used with the crop are superphosphate (or reverted superphosphate) and sulphate of ammonia. The usual practice is to sow from 1 to 1.5 cwt. of superphosphate or reverted superphosphate with the crop and topdress with 1 cwt. of sulphate of ammonia in spring. Ammoniated superphosphate is sometimes



used as a spring topdressing but in average seasons this fertilizer requires to be applied relatively early to obtain the full benefit from the phosphate fertilizer.

#### GRAZING AND CULTIVATION.

The period at which first grazings may take place depends on growth and seasonal conditions. Pastures are grazed lightly with sheep until the plants become more or less established, and under favourable conditions the earlier sown crops may be grazed by sheep three or four times before being closed for seed production. This applies, of course, to the better soils, as does also the time at which the pasture is closed for seed production. Generally speaking, late September or early October are suitable periods to close the fields for seed ; where the soil has become consolidated by winter stocking the pasture may receive a stroke or two of the tine-harrows subsequent to an application of sulphate of ammonia.

#### HARVESTING.

Areas closed for seed at the times indicated are generally ready for harvesting about the end of December or early January.

#### CHARACTERS OF MATURITY, TENDENCY TO SHED.

To determine the correct or best stage at which to reap Italian ryegrass, or, for that matter any ryegrass seed crop, requires considerable local experience. Drying, north-west winds are more or less prevalent during harvest time. Italian ryegrass sheds its seed readily under such conditions and if allowed to become fully ripe before harvesting considerable losses may be sustained. Most crops are therefore harvested when the seed has become well-developed, but not fully ripe. If the seed comes away readily when the ears are drawn through the hand, or into a hat when this is swept smartly across them, a start may be made with reaping. This is usually done to ascertain how the crop will *handle* and whether or not reaping can be delayed for a day or two without risk of serious seed losses. In sheltered spots the crop may be allowed to stand until practically ripe, but in most places it is harvested while still (to use a local expression) "a little on the green side."

#### UNIFORMITY OF RIPENING.

On level fields where the soil is more or less uniform, absence of uniformity in ripening is not regarded as a serious factor, but on uneven or undulating country ripening may be variable and necessitate the harvesting of the crop in sections.

#### METHODS OF HARVESTING. YIELDS. REMUNERATIVE CROPS.

The usual method of harvesting is to cut the crop with reaper and binder. The sheaves are stooked and allowed to remain in stook for ten to fourteen days. The material seldom goes into stack. Weather conditions are generally favourable for stook threshing and most crops are carted direct from the stook and threshed with the ordinary threshing combine. Yields are variable. On the heavier soils 50 and 60 bushels of seed per acre are not uncommon, but on the lighter soils, 30 to 35 bushels per acre of dressed seed would be regarded as a good yield. Occasionally a second seed crop, usually a very light one, is obtained in the one season. Such crops may be sufficiently thick and well-grown to harvest with reaper and binder, but more often the seed is taken off with the grass stripper or header harvester and hung on fences to allow the material to dry out before the seed is machine-dressed and placed in full sacks. This second crop is not usually regarded as a paying one and is taken only in exceptional circumstances.

Italian ryegrass is not susceptible to any serious diseases or pests in Canterbury. Occasional crops may be slightly affected with traces of rust, but the damage resulting from such attacks is, as a rule, negligible.

With varying prices for seed the seed crop is not regarded as particularly remunerative and many experienced farmers are of the opinion that it is as exhausting to the soil as a crop of wheat. A slightly enhanced price for certified seed has induced some growers of imported strains to leave areas down in the hope of obtaining a profitable seed crop in the second season. However, experiences in this direction have so far not been very encouraging. In most cases considerable dying-out of Italian ryegrass plants takes place, resulting in thin seed crops and relatively low yields in the second season. Moreover, perennial ryegrass impurities do not diminish appreciably, if at all, over a similar period. Therefore, areas which in their first season are sufficiently pure to pass readily as certified may in their second season contain altogether too high a percentage of perennial ryegrass to enable them to reach the certification standard for Italian ryegrass seed.

### Cocksfoot (*Dactylis glomerata*)

K. WELLER

Germany

DRY localities, in which cocksfoot with suitable cultural and manurial treatment produces the highest yields, are preferable for seed production. In moist localities on good loam soil it produces too much leaf, and seed formation is impaired. When earing, cocksfoot is very susceptible to injury by late frost. The fertile tillers freeze and die back, for which reason it should not be grown on moorland soils, where late frosts regularly occur. The most important district for cocksfoot seed production in Germany is the Mark Brandenburg; cocksfoot has been grown on a large scale there for a long time because good seed yield is obtainable on the light lands of that region. One of the most important cocksfoot seed producers is O. Schwietzke, Wahlsdorf, Kreis Jüterbog, who has been engaged in seed production for some decades. Cocksfoot is there sown under oats in a mixture with *Trifolium pratense*, or, on land unsuitable for red clover, with *Trifolium hybridum* and *T. repens*; the seeding rate is 20 kg. cocksfoot per ha. with 16 kg. red clover, or half the quantity each of hybrid clover and white clover, together with 100 to 110 kg. oats, in 20 to 25 cm. drills. In the first year after sowing the clover-grass mixture is used as fodder; when the weather and the development of the clover is favourable the second cut is allowed to stand for clover seed. The clover disappears in the winter, and in the two subsequent years the cocksfoot is harvested at the end of June to the beginning of July. The average size of field is 75 hectares from which a seed yield amounting to 250 to 300 dz.  $\approx$  3.5 to 4 dz. per ha. is obtained. The crop is mown with a self-binder, placed in cocks and in favourable weather threshed directly in the field.

The Lischow Seed Production Estate, Mecklenburg, drilled blue lupins, 80 kg. per ha. in 40 cm. drills, on light sandy soil in April, followed immediately by cocksfoot, 16 kg. per ha., sown exactly between the lupin drills, also in 40 cm. drills. The cocksfoot developed very well under cover of the lupins in the light soil, while on another plot, with oats as the cover crop, the grass was suppressed by the oats. The yield of lupins was 17 dz. per ha., while that from a pure culture of lupins in close proximity was 19 dz. per hectare. The cocksfoot gave a very good harvest in the first year. The grass may also be sown together with the lupins in the same drills.

As light lands are generally used for cocksfoot, it is best to sow in the early spring in a not too dense cover crop of summer cereals, or in autumn with a winter cereal.



Sowing in summer without a cover crop after rape, winter barley, and linseed is to be recommended only if there is enough rain in July and August. Planting distance varies from 20 cm. to 50 cm. drills with a seeding rate of 10 to 15 kg. per ha. The longer the field is to be used for seed, the wider must the space between the drills be, so that the field can be regularly hoed by machine or plough. Undesirable species, such as *Lolium*, *Festuca pratensis*, and *Bromus*, must be eliminated in good time. The seed is generally harvested two to three weeks before rye; harvesting must be done when the yellow-ripe stage begins, and single grains fall from the panicles when lightly shaken. The grain is still fairly soft and swollen; the seeds are fairly firmly attached and only when after-ripened do they fall more easily. According to the size of the field, mowing is done with a scythe, a mower with side-delivery platform, or a binder. Threshing on the field is done only in very hot weather, when the seed has after-ripened and is quite dry, otherwise the mown cocksfoot is stacked and is not threshed until frosty days in winter. Care must be taken that the seed is completely threshed out. If it is tough, it is firmly attached to the panicles and not entirely separated from the straw. For final cleaning a brush or huller is necessary in order to separate the many double grains, of which one is often sterile. The minimum purity required for certification is 94 per cent, germination capacity 90 per cent. When used for seed for several years, the fields must be well cultivated and heavily manured. The duration of use for seed may amount to three or four years and more.

Seed yield varies from 200 to 700 kg., the average being 400 kg. per hectare. The mean yield per hectare, with spring sowing, for all our production centres, was as follows:

with a cover crop, 418 kg. seed, 39.9 dz. straw;  
without a cover crop, 424 kg. seed, 42.2 dz. straw.

There was no difference in the average yield of crops grown with and without a cover crop. Sowing without a cover crop produced higher seed and straw yield in the first seed year, which then decreased from year to year. When sown with a cover crop the yield is highest in the second harvest year and then decreases. Seed yield varies greatly on the different farms; the best farm obtained from a sowing without a cover crop, from an area of 3.3 hectares, 744 kg. in the first year, 801 kg. in the second, 640 kg. in the third, and 450 kg. in the fourth. Kofahl, of Zernikow, harvested 1080 kg. seed in the first year, 452 kg. in the second, and 580 kg. in the third. With summer sowing, without a cover crop, the following harvests were obtained per hectare in July and August:

| Harvest year. |    |    |    |    |    | Number of seed grow-<br>ing centres. | Seed<br>kg. |
|---------------|----|----|----|----|----|--------------------------------------|-------------|
| 1st.          | .. | .. | .. | .. | .. | 6                                    | 292         |
| 2nd.          | .. | .. | .. | .. | .. | 6                                    | 458         |
| 3rd.          | .. | .. | .. | .. | .. | 5                                    | 408         |
| 4th.          | .. | .. | .. | .. | .. | 5                                    | 317         |
| Mean :        |    |    |    |    |    |                                      | 369         |

Summer sowing does not produce such good yields as spring sowing, development is not so vigorous and results are poor in the first year.

The most frequent diseases of cocksfoot are caused by different rusts (black and yellow) and by mildew, which are detrimental to the development of the leaves. Control is best ensured by selection for immune strains. Ergot also is often found on cocksfoot. Of animal pests the principal are wireworms and the frit fly (*Oscinis*), which destroy the young sowings as they come up. There have further

been recorded in our fields the larvae of *Apamea testacea*, which at the beginning of the growth period in early spring devour the crown of the root and the young flower shoots, so that no fertile tillers develop and seed formation is entirely inhibited. The butterfly takes flight in the autumn and oviposits in the borders of the field and upon the grass-grown field paths. It could be quite plainly seen that the larvae migrate from the grass path to the cocksfoot stands and destroy the latter. [From "Der Grassamenbau," (Grass seed production) by K. Weller, Arb. Reichsnährstandes No. 7. Berlin, 1936. pp. 55-60.]

**Timothy.**  
**(Phleum pratense.)**

**K. W. BRAID and**  
**A. BROADFOOT.**

**Scotland.**

TIMOTHY has been grown for seed in Scotland for many years. At one time the seed was grown in Ayrshire and Renfrewshire, but to-day most comes from the Carse of Stirling in the counties of Stirling, Perthshire and Clackmannan, with a little from the Carse of Gowrie (Angus). It is difficult to account for its discontinuance in Ayrshire. The rainfall was presumably slightly less and harvesting conditions on the whole better than in the present timothy seed areas. Even twenty-five years ago only a few farmers seeded small areas and these have steadily diminished. Various reasons have been given. It is suggested that the soil has steadily been becoming more deficient in lime and that the timothy was not growing so strong or so pure. Also the methods adopted led to the areas becoming polluted with weed seeds. Another reason was the use of earlier ripening oat varieties and the consequent clashing of the two harvests.

The main area where timothy seed is grown to-day centres around the town of Stirling; part on the northern bank and part on the south bank of the river Forth. The chief centres are the parishes of Lecropt, Kincardine (which includes most of the reclaimed Blairdrummond moss) and Port of Menteith in Perthshire; Kippen, Gargunnoch, Logie and Airth in Stirlingshire; Alva, Tillicoultry and Alloa in Clackmannan, all of which go to form the Carse of Stirling. This land is from 35-50 feet above sea level.

Although timothy has been grown for seed in this area only for about thirty years, it is not possible to say authentically who introduced the practice. To-day the crop of timothy seed is estimated at 200 to 300 tons per annum, but this is probably an under-estimate, for a proportion of the seed is grown for seed merchants and never appears in the open market. Parts of this grown-to-order seed is of the leafy strain type.

By no means the whole of the timothy hay is allowed to ripen seed. That portion is chosen which appears at flowering time as most suitable, but bad harvesting weather in any year may necessitate this being still further restricted.

#### RAINFALL.

The average rainfall for the town of Stirling is 39.8 inches per annum over 15 years (1920-1935) (1). In 1927 it was as high as 45.27 inches, and in 1933 as low as 26.18 inches. The western parts of south-west Perthshire have a higher rainfall than this (45 inches), but that part of the Carse in which the timothy seed is produced has possibly an inch or even two less, and certainly not more than Stirling.

(1) Transactions of the Highland and Agricultural Society of Scotland. Yearly meteorological reports (1920-35).



## SOIL.

The land for many miles up the Forth from Stirling is flat and originally consisted of great areas of peat bog overlying clay at about 30 feet above sea level. From the latter half of the 18th century, much of this was reclaimed by cutting off the peat and flushing it into the Forth. The reclaiming of the peat "moss" was initiated by the famous Judge, Lord Kames, and completed by his son and successor, George Home Drummond (H. M. Cadell, 2).

After the removal of 3 to 12 feet of peat the underlying heavy carse clay was exposed. This is greenish or blueish in colour and free from stones. Apparently it was well limed from lime kilns on the Campsies and dressings of six to eight tons per acre were usually applied. Although for the past thirty years little further liming has been carried out, the land is not so markedly deficient as one would expect and in extreme cases would not demand more than two tons per acre. Apparently available phosphates are in many cases deficient, but the available potash is usually adequate.

For many years throughout the Carse area almost the only manures used have been dung and sulphate of ammonia or nitrate of soda—chiefly sulphate of ammonia owing to its price.

## ROTATIONS.

The regulations regarding rotations have been lax. Cases are known where timothy has been seeded for periods up to ten and even twenty years. As a rule Yorkshire fog (*Holcus lanatus*), florin or bent (*Agrostis* sp.) and to a less extent horse-tails (*Equisetum*) and docks (*Rumex* sp.) make it necessary to plough up in about the eighth to the tenth year, but the period depends wholly upon the length of time the ground can be kept clean.

Timothy is generally sown with a cereal (usually oats) after beans, mashlum or turnips, but sometimes it succeeds fallow. The ploughed-up timothy is usually followed by beans, mashlum or oats.

The common rotation is :—(1) beans or mashlum, (2) oats or, owing to the recent subsidy, wheat, (3) fallow or green crop, (4) wheat, (5) beans, (6) cereal (oats) with timothy. The land sometimes receives stable manure after the wheat (4) and sub-soiled and sown out with cereal (oats) and timothy, as beans (unless a thick stand is obtained) are apt to allow the land to become weedy. A four course rotation is :—(1) beans or mashlum, (2) oats, (3) turnips or fallow, (4) oats and timothy. While the cereal nurse crop usually follows beans or mashlum, there are those who prefer to sow after turnips, and one year's ryegrass has been known to be taken off in place of turnips. Some farmers grow no green crop and a few others use rape as the nurse crop after fallow.

## SOWING METHOD.

The "seed" is generally sown broadcast by hand or by means of the broadcast harrow. It is difficult to sow timothy mixed with red clover satisfactorily by hand as the heavier seeds of the latter go further, but some experts, using the first two fingers and thumb of either hand and sowing five yards at a time, can sow 18 lb. clean timothy to the acre. Where a nurse crop is used, oats are usually sown first and rolled in and last of all the small timothy seeds are scattered on the top, where they roll into depressions. Some farmers, however, find it possible to sow pure timothy and cut a crop for seed the second year. This is unusual; when sown with oats a hay crop is removed in the second year and the timothy cut for seed in the third season.

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(2) Cadell, H. M.—"The Story of the Forth," 1913. pp.262-284.

## SEED RATE.

Formerly 18 to 20 lb. timothy seed per acre was used, but the modern tendency is to reduce this, except for timothy without a nurse crop, even to 10 to 12 lb., and all amounts between these two extremes are used. A common rule is to broadcast "as little as it is possible to sow."

## NURSE CROP.

Timothy for seed is either sown after fallow in June-July alone or with rape, or it is sown in the spring with a cereal. It keeps most weed-free if sown with barley or oats. Barley is possibly more suitable than oats, and probably the best nurse crop owing to its standing power, but it is not used extensively to-day for economic reasons. With oats there is a good outlet for the grain and a use for the straw as fodder. Wheat is generally held to give poor results, probably because it is too far advanced when the timothy seed is sown. Oats are sown at 170 to 250 lb. per acre (4 bushels of sandy oats or up to 5 or 6 bushels of grain-producing varieties, e.g. Victory or Marvellous, to the Imperial acre). Italian ryegrass with timothy is becoming less common, and about 10 lb. per acre is used, although some farmers double this. Its purpose is to exclude weeds, especially Yorkshire fog, for the first year or two. In addition, clovers are usually included. While red clovers, especially broad-leaved red, at 1 to 4 lb. (average 2 lb.) are the most usual, alsike clover at 1 to 2 lb. is sometimes also sown. Wild white clover (0.5 lb., seldom more) is occasionally included, for it improves the grazing of the aftermath if the timothy is cut green for hay. It appears to be generally agreed that if too much Italian ryegrass and alsike clover are used, they have a tendency to bulk overmuch in later years. As a rule, not more than 4 lb. of clovers in all are sown.

## TIME OF SOWING.

During the last two years in order to "catch the tid" or optimum soil conditions, sowing has been earlier than usual, about the first half of April: frequently, however, it is well into May before the seed is sown. The rate depends on weather and soil conditions. Fallow-sown timothy is generally sown about the end of June or early July.

## MANURING.

In general the only dressing is nitrogen. Nitrate of soda was once very widely used, but price conditions and possibly its deleterious physical effect on the soil have gradually led to its being ousted by sulphate of ammonia. The land usually receives stable manure for the bean crop previous to the sown cereal crop. Unless a good thick stand of beans can be obtained, the land is apt to become fouled with weeds. To avoid this, the land is sometimes given stable manure following the wheat crop and subsoiled, and oats and timothy sown in place of beans. This practice seems to be increasing, as it is held to give cleaner timothy. Stable manure is not applied on the surface as it encourages weeds and "soft grasses" (Yorkshire fog). The common dressing is sulphate of ammonia applied in two, three or more doses to a total of 3 to 5 cwt. (N = 67-112) per Imperial acre, beginning towards the end of March; this is repeated year after year. Nitrochalk [1.5 cwt. (N 26) towards the end of May] is now partially replacing sulphate of ammonia. Recent manuring experiments have demonstrated the value of phosphate and also of potash and the use of potassic basic slag is becoming more common. Basic slag [6 cwt. (P 87) in winter] gives an increased yield of seed, and in one or two cases it has been found that the addition of potash [10 cwt. potassic basic slag (K 67 : P.112) in autumn]



has increased the yield of seed further and that the increase has been shown particularly in the size of the grain. As a large-grained sample always commands a better price, this is a decided advantage. Liming at the time of sowing is also becoming a more general practice. In the case of timothy (in oats) following turnips, which have been slagged at 4 to 5 cwt. (P 58-73) per acre, 3 cwt. of superphosphate (.53 P) is sometimes given.

#### CULTIVATION.

Timothy for seed production is harrowed in the early spring or in autumn and early spring with spring-toothed harrows. This is done while the ground is soft, frequently after frost, and is intended to clear the ground of weeds and to prevent the plants becoming too thick, as the best ears are borne on a few vigorous tillers. The crop is often torn up until the ground is very plainly visible. While many farmers harrow yearly, others do so only occasionally or at the end of a few years to renovate old or thick timothy and to clean dirty fields. Rolling often takes place in the spring.

#### GRAZING.

The grazing of timothy aftermath is generally light. Cattle are used to take off the top growth and are usually followed by sheep during August, September and October, but sheep in Carse land are liable to develop "foot-rot". Horses are close grazers and are apt to pull the timothy "bulbs" out by the roots; they are not usually allowed to graze the aftermath. The fact whether the fields are fenced rather determines the type and amount of grazing. Much of the Carse of Stirling is unfenced with wide ditches or "levels" separating the farms. The grazing is always lightest in the first year and never excessive, especially if the weather is wet. Some farmers graze from autumn until April; others do not graze at all. Too late grazing in the spring reduces the following crop of timothy.

#### HARVESTING.

This takes place in August, usually from mid-August onwards. It has to be done when the crop is almost ripe.

#### CHARACTERS OF MATURITY.

The stem may be still slightly greenish, but the upper parts and the ears are a reddish-brown (biscuit colour). The chief character is a slight tendency for the seed to be shed from the apex of the ear. A slight baring of the tip of the main axis for about 0.25 to 0.5 inch is the best indication of the correct time to cut. The best seeds are on the ear and the smallest at the top. The ear "strips" easily at this stage when the hand is pulled up the head; it is a good sign when the sheath of the binder becomes white with seeds and fragments of the white paleae rise as dust. At this stage the seed is most profitable to harvest, for if it is at all immature, it shrivels up on drying and is more liable to heat in the stack. Selecting the correct day is very important, because a windy night after a shower may lead to a very considerable loss by shedding. When only the tip strips, the whole ear is not dead ripe, but possibly will be so within two or three days.

#### UNIFORMITY OF RIPENING.

The consensus of opinion in Scotland is that this is very steady. Various observers have said that 80 to 95 per cent of the seed may be ripe at the same time, but it appears to differ with the season, being best in dry weather. In the authors' opinion there appears to be a few days difference in the ripeness of the top grains

from those lower down, but if there are not too many tillers, the heads ripen very uniformly. The more careful growers insist on large thick straws, which they obtain by harrowing out all the weaker tillers; this incidentally promotes uniform ripening.

#### TENDENCY TO SHED.

Shedding is one of the worst troubles in the harvesting of seed of timothy. It is especially prone to take place after rain, for apparently on re-drying the glumes open wider. The result is that in wet and windy weather the seed may be shed in a night. If the weather is dry, shedding is not serious unless the ear is over-ripe, but wet weather while it is in the stook makes subsequent handling difficult. Unripe timothy is not very liable to shed, but gives seed of poor quality and the straw is liable to heat in the stack. Ideal harvesting weather would include a shower while the timothy is in the stook. Even without this, when the crop is being carted, the carts become covered with seeds which are carefully collected.

#### METHODS OF HARVESTING.

The crop is cut by binders; since the stem is hard, harvesting is difficult and tractor-drawn binders are often used. The sheaves are about 9 to 12 inches in diameter and the knives are set to leave a fair length of stubble. This excludes ground herbage and shortens the drying period. The straw when dry is smooth and slippery and if sheaves are tied too near the top, there is a danger of serious shedding of grain during forking. The sheaves are stooked in fours, sixes or eights. Four sheaves per stook is probably best, but if the weather is windy, sixes are firmer. Some farmers, however, prefer a 9 to 10 inch sheaf and stook in sixes or eights. In wet weather the sheaves are frequently "hutted" or "rickled." This is done by building the sheaves into a small conical stook containing about 80 sheaves (60 to 100) over which a sheaf is placed to act as a hood. The whole is tied down with straw or rope. The advantage is that it lifts the bulk of the sheaves off the ground, exposing the bottoms to the wind and protecting the bulk of the grain. In building these into a stack later, care is taken to arrange the basal sheaves in the circumference of the stack so that their bases can dry.

#### DAYS IN THE FIELD.

Again this is a question of the weather conditions. If the weather after cutting is good and the crop dry, two to four good days are usually considered to be sufficient. If the crop is dry it is secured usually within the first week, but if the weather is settled it takes no harm standing for a week or more. If, however, the heart of the sheaves is not dry, they may remain in the stook for upwards of a fortnight. Owing to its tendency to shed, the aim is to collect the crop as soon as it is dry. A shower will be beneficial, but a period of wind and rain may be disastrous. The crop is stacked into large oblong stacks or "sows".

#### TIME OF THRESHING.

Other harvesting operations generally prevent the timothy seed from being threshed at once. It is seldom started before September-October and frequently it is done later, even up to February. If markets are good, it is threshed as soon as possible, generally before the New Year.

If the seed has not been absolutely ripe when harvested, trouble is caused in threshing, as special riddles and fanners have to be fitted to the mill and the setting made very fine. This fine setting of the drum is liable to skin the outer silky skin (or paleae) off the seed.



## DRESSED SEED.

It is difficult to obtain absolutely reliable data on this point. The amount varies so much with the conditions under which the seed was harvested—three to five cwt. (336 to 560 lb.) per acre is common, but 8 cwt. (896 lb.) has been obtained under favourable conditions by special treatment. 500 lb. can be taken as a good average yield of seed, although some farmers exceed this almost every year.

In timothy seed samples as sold to the seed merchants, the impurities frequently consist of 0.1 to 2.0 per cent inert matter and 0.1 to 1.4 per cent of crested dogstail seed (*Cynosurus cristatus*). Traces of florin and Yorkshire fog are common; the former may reach 7 per cent. In ordinary samples, however, there may be traces of one or more of the following :—*Poa*, *Lolium* spp., *Festuca ovina* and alsike clover among the useful plants, and such weeds as *Rumex* spp., *Cerastium* spp., *Sonchus arvensis*, and *Prunella vulgaris*.

The prices obtained by farmers for timothy seed has ranged from 20s. to 120s. per cwt. Two years ago it was in the vicinity of 100s., but the average price is about 45s. to 50s. per cwt.

## NUMBER OF REMUNERATIVE CROPS.

In well-treated land the usual reason why the crop becomes unprofitable for seed production is because it becomes too weedy. Yorkshire fog and florin are the most common troublesome weeds. These can be kept in check by harrowing for a number of years. In a crop of timothy laid down with oats, a hay crop will most probably be taken in the second year and the first seed timothy secured in its third year; if it becomes lodged or is poor, the seed crop will not be taken until the fourth year. As a rule, three to five paying seed crops can be obtained. Sometimes, owing to lodging, bad weather, or too light a crop, hay has to be taken instead. There are cases of timothy being used for seed after 10 to 15 years; if it is kept clean and well-manured, there is no reason why many crops should not be removed. Only the cleanest and strongest of the timothy is preserved for seed, the remainder being cut earlier and made into hay in the ordinary way. Curiously enough, threshed hay is worth almost as much as green-cut hay, although one would expect its feeding value to be much lower. It is, of course, sold baled from the thresher, while green cut is sold loose. Threshed hay is much used as chaff for horses.

## FUNGUS DISEASES AND INSECT PESTS.

Timothy hay in the Carse of Stirling is remarkably free from serious fungoid pests. The most serious trouble has been caused by the timothy grass fly, *Amaurosoma armillatum* Zett. A few years ago this had assumed alarming proportions and was causing a loss up to 50 to 60 per cent of the heads in certain spots and an estimated total decrease of 20 to 25 per cent of the total seed crop. This fly and its incidence on the timothy seed hay crop has recently been studied by Barnes (3 and 4) at Rothamsted, and by King and Meikle (5) and King, Meikle and Broadfoot (6) in the Stirling district.

- (3) BARNES, H. F. Notes on the timothy grass flies (*Amaurosoma* spp.) *Ann. appl. Biol.* 22. 259-66. 1935.
- (4) ABERYSTWYTH, Imperial Bureau of Plant Genetics: Herbage Plants. Bull. No. 20. Insect and other pests injurious to seed production in herbage and forage crops. By H. F. Barnes. Aberystwyth, 1937, pp. 31.
- (5) KING, L. A. L., and MEIKLE, Agnes A. A fly pest of timothy grass. *Nature*. 131. 837. 1933.
- (6) ————— and BROADFOOT, A. Observations on the timothy grass fly (*Amaurosoma armillatum* Zett.). *Ann. appl. Biol.* 22. 267-78. 1935.

Larvae from eggs laid in May become full-grown in about 15 days, fall to the ground to pupate and remain there until the following spring. About 40 per cent of the puparia kept under observation in 1933-34 yielded hymenopterous parasites (*Seladerma lactum* Walk., for the greater part and a few *Dacnusa semirugosa* Hal. in this case).

#### CONTROL.

The cessation of the fly attack in 1935-36 suggests that the parasites have checked the epidemic, at least for the present, and experiments on the effects of different manures and the use of deterrents have been suspended meantime. These suggested, however, that basic slag dressings gave a slight inhibitory effect, but that sulphate of ammonia increased the liability to attack. Crude naphthalene in groundnut oil was a promising deterrent.

During the course of the epidemic, gulls were sometimes in great evidence among the timothy and probably accounted for many of the flies; on one occasion many lapwings were observed, presumably seeking for the puparia.

#### ACKNOWLEDGMENTS.

We would like to express our thanks to Miss Catherine Aitkenhead, N.D.A., County Organizer for Stirling, for her valued assistance, and to acknowledge our indebtedness to the farmers of the Carse of Stirling for their unfailing, friendly co-operation and especially to Mr. Thomas Bryce (Chalmerston) and Messrs. Andrew McFarlane (Upper Westwood), Paterson (Powblack), Alex. Moir (Little Ward) for their helpful criticisms, and to Messrs. James Gray and Co., McEwan Stirling Grain Co., Mr. Watt of Messrs. Drummond, and Mr. Dewar, of Messrs. Gartshore, all of Stirling, for information supplied.

**Timothy.  
(*Phleum pratense*.)**

**G. NILSSON-LEISSNER.**

**Sweden.**

In Sweden timothy is the most important grass for hay production. It is grown for seed mainly in southern and middle Sweden (between 55 and 61° north latitude), although many seed fields are found in the eastern coastal range up to 66° north latitude. The annual rainfall in the seed producing districts varies between 500 and 800 mm., but as the humidity of the air is rather high, the climate is generally rather humid. Timothy is grown on practically all types of soil, except on pure sand, but the best yields are obtained on clay, loam or peat soils. In districts of intensive agriculture (Skåne, Östergötland, and other provinces) where sugar beet is also grown, timothy seed production is most intensive. Here short rotations of four to seven years are mostly used, although in the woodlands and in the northern part of the country long rotations of eight to ten years are common and farms are found with up to 75 per cent of the arable land carrying hay crops. The annual consumption of timothy seed in Sweden is about 7,000,000 kg., but usually the production is much greater and considerable quantities are exported.

Sowing methods vary widely. In most cases broadcasting, broad drill sowing, or drilling in rows 10 to 12 cm. apart are still used, but in southern Sweden where special fields are used for seed production, the practice of drilling in rows 40 to 45 cm. apart is now becoming more common. Most timothy seed is still produced on ordinary hay fields sown with a mixture of one-third timothy and two-thirds red clover, where the farmer sets aside a certain part of the field for seed production.



In such cases the entire field is often cut for hay in the first, and also in the second year, and when the clover later becomes thinner, the field is put up for seed. For such cultures early broad-leaved clover is often used in place of the more common late type, because the former cannot stand the Swedish winter climate and usually disappears completely after the first harvest year.

In mixtures with clover the seed rate of timothy is 10 to 20 kg. per hectare, depending upon latitude and height above sea level; in pure stands sown in rows 40 to 50 cm. apart, 5 to 8 kg. of seed per ha. are used. Spring cereals and especially spring barley are generally used for nurse crops, but in middle Sweden winter wheat and winter rye are also used. In the latter case, the timothy is either sown at the same time as the cereal or early the next spring, sometimes even before the snow has thawed. In the former case the end of April or the beginning of May is the usual time for sowing. In the north of Sweden it may often be delayed until the beginning of June.

Phosphates and potash are given to the timothy fields in varying rates; in many districts they are not used at all. Pure stands of timothy usually receive 100 to 200 kg. per ha. of nitrates or sulphate of ammonia in the autumn, and 300 to 400 kg. in the spring. Seed fields sown in rows 40 to 45 cm. apart are regularly horse-hoed in the autumn and in the spring. The seed fields are sometimes grazed in the autumn, but it is considered better to cut the aftermath with a machine. The harvest takes place in the latter part of July or beginning of August and is usually done by means of a self-binder. The seed is considered to be ripe if the tops of the heads begin to shed when knocked against the hand and the flower-glumes have acquired a silvery lustre. In the now commonly used pure bred varieties the uniformity of ripening is quite-satisfactory. In order to counteract the tendency to shedding, five to six sheaves are put up together in small round shocks which are bound with strings around the tips. The entire shocks are later loaded on a wagon which is covered by a cloth. The shocks are left to dry in the field according to weather conditions. On large farms in southern Sweden the seed is generally threshed out of the field; in other cases it is stored from December to February and threshed in the cold weather when the chaff is brittle. The yield of dressed seed is 300 to 600 kg. per ha.; the mean yield in the most southern part of Sweden is about 500 kg. The first simple cleaning of the seed is always done on the farm, but later cleanings are often made in special co-operative seed cleaning establishments. On well cultivated and manured fields and on soil free from weeds, seed can be harvested with good economical results for seven to eight consecutive years, but in most cases the seed fields are ploughed up after two to four years for their rotation to be completed.

Parasites of some importance include the fungi: *Puccinia phlei-pratensis*, *Epichloe typhina* and in the northern part of the country *Sclerotinia borealis*; these do not, however, usually have disastrous effects. Among insects the larvae of *Cleigastra flavipes* and *Tortrix paleana* sometimes cause great damage, as does *Hadena secalis*, the bites of which result in the withering of the last straw internode and of the whole head. The fungous diseases are controlled by means of resistant varieties. Effective remedies for the insects mentioned are not known.

**Timothy.**  
**(*Phleum pratense*.)**

**M. W. EVANS.**

**United States**  
**of America.**

In the northern part of the United States, timothy (*Phleum pratense* L.) is used far more extensively than any other grass for hay production. In certain parts of the

country it is also harvested for seed. During the years 1925 to 1930 an average of 520,000 acres, producing approximately 2,000,000 bushels, or 90,000,000 pounds of timothy seed was harvested annually. Approximately 90 per cent of the total timothy seed crop is produced in the five states of Iowa, Missouri, Illinois, Ohio and Minnesota.

In general, timothy thrives on clay or silt loam soils which are quite retentive of moisture, better than on the more sandy soils.

#### RAINFALL.

Over the timothy seed producing area, the average annual rainfall ranges from about 29 inches in southeastern Minnesota and 32 inches in Iowa, to 37 inches in northern Missouri and central Illinois. The greatest amount of precipitation occurs during the spring and summer months. In Iowa, the most important seed-producing state, 50 per cent occurs during May, June, July, and August.

#### TIMOTHY CULTURE.

In general, a timothy meadow receives the same cultural treatment if used for production of seed as for hay. In the more common rotations in which timothy is grown, the meadows are maintained for one, two, or three years, and occasionally longer. In the first year a timothy meadow usually contains a mixture of clover, and the crop is harvested for hay. A timothy seed crop may be harvested in the second or later years.

Timothy is usually sown with some grain as a nurse crop. Where winter wheat or rye are grown, meadows are sown with them more frequently than with spring grain. The seed may be sown at the same time as the grain, or may be sown on the surface of the soil at the same time as the clover in early spring. Sometimes part of the timothy is sown in the autumn, part in the spring. Where winter grain is not grown, the meadows are sown with a spring grain—most commonly oats.

If all the seed is sown at the same time as winter grain in the autumn, best results are obtained with not more than three to five lb. of timothy. When the grass seed is sown in the spring, from six to ten lb. per acre are generally sown.

Timothy seed may be sown with the grass seeder attachment to the grain drill; or it may be sown with a hand seeder and lightly covered with a spike-tooth harrow or other implement. If sown on fields of winter grain in early spring, it may be harrowed in, but is generally left to be covered as a result of the action of freezing and thawing upon the surface of the soil.

Timothy meadows used for seed production are seldom fertilized. If, however, applications of nitrogen are made in the spring, the percentages of increase in the yields of seed equal or even exceed the increases in yields of hay.

During the late summer and autumn months, after the seed crop has been harvested, the meadows are often pastured. They are not very frequently pastured during the spring.

#### HARVESTING AND THRESHING.

Timothy seed is harvested from about July 20 to August 10. The time of maturity is indicated by the heads and upper parts of the stems becoming straw coloured, and by seed beginning to shatter from the tips of a small proportion of the heads. If cut at about this stage, relatively little seed is lost through shattering.

Most of the timothy harvested for seed is cut with a grain binder. The bundles are placed in shocks, where the crop is usually left to dry for one to three weeks. Although the timothy is sometimes stacked, the more common practice is to thresh directly from the shocks, sometime in August. The crop is threshed with the ordinary



grain threshing machines. Finer sieves are ordinarily used than for grain, and the current of air is reduced so that the seed is not carried through the machine with the straw and chaff. If the speed of the cylinder is reduced to about 800 to 900 revolutions per minute, and the teeth of the concaves do not mesh with those of the cylinder more than about one-fourth of an inch, the proportion of seeds from which the hulls are removed may be much reduced.

In limited areas, timothy seed is harvested with grain headers. The stems are cut off a few inches below the heads. The heads are placed in small cocks to cure, and are then threshed in the usual way. In recent years, timothy has sometimes been harvested with grain combines.

Seed, as it comes from the machine, is described as "country run". It is generally sold in this condition, on the basis of the percentage of timothy seed which it contains. After it has been recleaned by special machinery, good grades of seed commonly contain 99 per cent or more of timothy.

#### FUNGOUS DISEASES AND INSECT PESTS.

There are not many diseases or insects which cause serious injury to timothy.

In some areas rust (*Puccinia phlei-pratensis*) becomes more or less severe in timothy meadows. Some of the recently developed improved varieties have been found to be more resistant to this disease than ordinary timothy. The timothy joint worm (*Isosoma* sp.) often causes some of the heads to dry prematurely.

#### THRESHED TIMOTHY AND HEADED TIMOTHY HAY.

Both threshed timothy, and the hay mowed after the seed crop has been harvested with a header—known as "headed timothy"—are used as roughage for farm stock. In a number of samples of threshed timothy hay, the average percentage of protein was 3.05, and in a number of samples of headed timothy it was 3.70; these figures are only approximately one half as high as in timothy hay harvested at the stage of early bloom.

**Meadow Fescue.**  
(*Festuca pratensis*.)

**K. WELLER.**

**Germany.**

*Festuca pratensis* is one of the best perennial top grasses for meadows, pastures, and forage crop production; it is a tufted grass, and attains a height of 60 to 100 cm.

The best soil for seed production is fresh, good, humus mineral soil, where there may be also periodical flooding; on pure moorland soil it generally forms great leaf bulk. With the late frosts which regularly occur at the beginning of June in moorland, the flower is often damaged and seed yield unfavourably affected. A greater danger, particularly on the moister moorland soils, is that of lodging. *Festuca pratensis* is sown from early spring up to the autumn. The later sowing is done, however, the less is seed yield in the following year. The most successful practice has been sowing under summer barley in rows from 30 to 50 cm. apart at 12 to 15 kg. per hectare in accordance with the weather conditions. The drier the situation the closer must be the drills, but the more grassy the district, the more widely does one drill. In dry places with little weed growth, *Festuca pratensis* is sown diagonally across the barley drills. In rainy localities the barley is sown in wide drills and the *Festuca pratensis* drilled between the rows.

The Steinach Seed Breeding Estate near Straubing uses as a cover crop the short-strawed pea "Buxbaum" (seed rate 110 to 125 kg.) or linseed (75 to 80 kg.),

sown in early spring in 50 cm. drills. When the peas are 8 to 10 cm. high, or linseed 5 to 7 cm. high, 15 to 18 kg. *Festuca pratensis* per hectare are also drilled in at a distance of 50 cm. exactly between the rows of the cover crop. The fescue may also be directly mixed with the peas or the linseed and both crops sown together, a still more simple process. There is then no harm in sowing somewhat deeper, because the soil is easily penetrated by the seedlings of the peas or the linseed, and the way is left free for the grass seedlings. If the cover crop of the fescue is correspondingly widely sown, it is possible to hoe with a machine, protective disks being used. *Festuca pratensis* may also be drilled with 15 kg. *Trifolium pratense* as a clover-grass mixture on lighter soils, or it may be sown in 30 to 35 cm. drills, at 12 kg. per hectare, under 10 kg. *Trifolium pratense* and 6 kg. *T. hybridum*. In the next year two forage cuts are taken, and when there is good aftergrowth grazing may be obtained. The clover dies back in winter and the fescue may then be used for several years for seed. If meadow fescue is sown under a cover crop, when the latter is harvested the young grass sowing should be manured with a readily soluble nitrogenous fertilizer (calcium saltpetre, calcium ammonium saltpetre) and should be frequently hoed, weeded and harrowed so that the stand is clean and develops vigorously. The better the cultivation in the seed year the higher is the yield in the first harvest year. Sowing may be done in summer without a cover crop after rape, linseed and winter barley. When these crops have been harvested the field should at once be ploughed to a medium depth, fertilized with potassium phosphate and some nitrogen, tilled to garden consistency and *Festuca pratensis* sown in 40 to 50 cm. drills at 15 kg. per hectare. This process produces as a rule only one-third to a half of the normal seed crop in the first harvest year. In the middle of August one may sow 15 kg. *Festuca pratensis* together with 20 kg. *Trifolium incarnatum* per hectare at a distance of 25 to 30 cm. In the first year the crimson clover is harvested either as green fodder or hay, or is left standing for seed, and the meadow fescue is used from the second year onwards. The seed should be lightly drilled, rollers being used; it comes up in about 14 days. As *Festuca pratensis* forms tufts it does not grow together, and can therefore be hoed as often as necessary with a machine. Invading grasses such as *Lolium perenne*, *Lolium italicum*, *Dactylis glomerata*, *Phalaris arundinacea*, *Festuca rubra*, *Agropyron repens*, *Bromus arvensis* and *B. mollis*, which cannot be eliminated when the seed is cleaned, should therefore be eradicated.

Harvesting takes place from the beginning to the middle of July, approximately 10 to 14 days before rye. At maturity the paleae assume a faint brownish colour, and the haulm becomes straw-like under the panicle. As *Festuca pratensis* tends to shatter, harvesting must be done in good time when the seed is at the yellow-ripe stage. The seeds do not all ripen at the same time; if the uppermost grains fall when one strips the panicles through the half-closed hand it is time to cut. Seed should be harvested with a binder, a side-delivery reaper, a hay-mower with a reaping attachment, or a scythe early in the morning when the dew is on the ground, or under a cloudy sky. When the binder is used, a box should be attached so that falling seed may be caught. If there are still many leaves at the base of the grass, as high a stubble as possible is left; the stubble is later cut with a hay-mower and the green leaves used for hay. When mowing is done with a side-delivery reaper, hay-mower or scythe, the seed straw is arranged in cocks. When the seed is well dried, that is to say is completely hard and the straw is dry, it is carried in carts lined with sheets or, if possible, it is threshed in the field. The seed is very easily separated from the straw. In threshing only, a reduced current of air is used, the cleaning apparatus being allowed to run and the seed given a preliminary cleaning. Care must be taken, however, to prevent germinable grain from mixing with the chaff. The seed is shaken out in the store-room in a layer 15 to 20 cm. deep, and turned over with a shovel once a day



if necessary, until completely dry. Cleaning may be done with any good fan, a correspondingly fine sieve being used, but here also care must be taken that no good seed is lost. With a fan the minimum purity required for seed certification, 96 per cent, can always be obtained; the requisite germinability is 92 per cent. If double grains are found during cleaning, these should be separated from one another by means of a huller. If the seed contains weeds such as *Polygonum*, *Rumex acetosa*, etc., it is best to send the dry, pre-cleaned seed to a special seed-cleaning centre. The best pre-cleaning, however, is that which is done in the field; if the stand in the field is clean, cleaning with a fan presents no difficulties.

A field of *Festuca pratensis* may be used from 3 to 5 years, according to the soil, manurial treatment and state of cultivation; on poor soils a stand generally deteriorates greatly in the third year. According to our enquiries, seed yield amounts on an average to 400 kg. per hectare and varies from 200 to 900 kg. The average production per hectare of all our seed growing centres was, with early spring sowing, as follows:

| Harvest year. | With a cover crop.                 |          |           | Without a cover crop.              |          |           |
|---------------|------------------------------------|----------|-----------|------------------------------------|----------|-----------|
|               | Number of seed production centres. | Seed kg. | Straw dz. | Number of seed production centres. | Seed kg. | Straw dz. |
| First. ....   | 82                                 | 474      | 42.7      | 22                                 | 703      | 48.8      |
| Second ....   | 62                                 | 478      | 45.6      | 22                                 | 562      | 43.8      |
| Third ....    | 54                                 | 394      | 36.3      | 22                                 | 448      | 40.1      |
| Fourth ....   | 32                                 | 371      | 35.8      | 18                                 | 415      | 38.1      |
| Fifth .....   | 5                                  | 289      | 34.1      | 18                                 | 356      | 33.2      |
| Mean :        |                                    | 401      | 38.9      |                                    | 497      | 40.8      |

Sowing in spring without a cover crop produced on an average 98 kg. more seed than the sowings grown with a cover crop; in straw yield there is no significant difference. In the first harvest year especially, *Festuca pratensis* sown without a cover crop gives a yield of approximately one-half more than when sown with a cover crop. Certainly the cover crop itself is lost, and also there is more hoeing to be done. The yield decreases from the third year onwards when *Festuca pratensis* is sown without a cover crop; the yield is very good in the first two years, but then diminishes. Here again certain farms obtain very high harvests. For example a farm in Lower Franconia, very well situated for grass seed production, produced, with spring sowing and without a cover crop on an area of 2.1 hectares, 850, 870, 550, 586, and 595 kg. pure seed per hectare in five harvest years. Thus it depends entirely upon situation, soil, climate, manuring and care. Farms of this kind should be utilized especially for the reproduction of grasses. With summer sowing, principally after winter barley in July up to the beginning of August, without a cover crop, the following yields were obtained per hectare:

| Harvest year. | Number of seed production centres. | Seed kg. |
|---------------|------------------------------------|----------|
| First. ....   | 16                                 | 365      |
| Second ....   | 14                                 | 531      |
| Third ....    | 12                                 | 403      |
| Fourth ....   | 8                                  | 367      |
| Mean :        |                                    | 416      |

From this it is clear that crops sown later, from July to August, did not give a high yield for the first harvest year, but in compensation gave higher yields in the second year. On an average, yield is equivalent to that of stands sown in spring without a cover crop.

Of fungous diseases yellow rust (*Puccinia Festucae*) on the upper side of the leaf should be mentioned in the first place; it occurs in the second cut, and is often so widespread that plants and soil alike look quite yellow from the spores. Black rust also is found on the haulm and leaf sheaths, and crown rust upon the leaves. Control is best effected by breeding through selection, all susceptible strains being eliminated. Animal pests observed include slugs, wire worms and frit flies in the young sowings, destroying young leaves and shoots. White ear also occurs in *Festuca pratensis*; the ear and panicles of the inflorescences become quite sterile and white, and no seed is set. Heavy attacks can destroy a whole field. The causes of this damage are mite species, thrips, frit flies, gall midges, the larvae of small butterflies, *Tipula* species, aphids, frost and drought. White ear is most liable to occur on uncultivated stands; the best course then is to plough up the field. Where such damage occurs frequently, it is well to abandon the stands for grass seed production, as conditions are more favourable in older stands for distribution of the pests.

[From "Der Grassamenbau." (Grass seed production.) by K. Weller. Arb. Reichsnährstandes. Vol. 7. pp. 48-55. Berlin, 1936. *Herb. Abstr.* 6. 232. 1936.]

### Red Fescue. (*Festuca rubra*.)

K. WELLER.

Germany.

*FESTUCA rubra genuina* is a very persistent, rhizome-forming bottom grass, 40 to 70 cm. high. It is not exacting in its requirements, occurs on all types of soil, and through its widely branched subterranean shoots forms a dense, matted sward, which, when sown in single cultures, does not readily admit the intrusion of another plant.

For seed production dry soils are principally used, because of better seed formation; in moist localities, especially on moorland soils, the grass runs to leaves and forms little fruit. It is generally sown in early spring under a cover crop, preferably summer barley, which is drilled 20 cm. apart, 40 cm. between the rows. Among this, immediately after the barley has been sown, 10 to 12 kg. red fescue per hectare are sown in rows 60 cm. apart. If there is a tendency to weed growth, the sowing may be delayed until the barley has been hoed. Red fescue may also be drilled across the rows of a sparsely-sown cover crop. The Steinach Seed Breeding Station recommends sowing at the rate of 10 to 15 kg. in the spring under the short-strawed pea or linseed.

As red fescue is very slow in its early development, we have found early sowing to be best, because it results in higher seed yields in the next year. As a summer sowing it may be sown after rape and winter barley without a cover crop, but the seed should be in the soil not later than the middle of July, as otherwise the seed yield in the next year is very low. After the cover has been harvested cultivation of the seed crop must begin at once. The application of a rapidly effective form of fertilizer is advisable, so that the sowing shall develop well before the winter.

In older seed fields the growing together of the rows should be prevented by vigorous rooting-out and hoeing after the seed harvest, for which a cultivator may be used. The Steinach Seed Breeding Station has used with good effect a cultivator made by the Eberhard Plough Factory at Ulm; the shares are attached to two strong



rectangular irons, and their position may be regulated at will. There is a distance of 75 cm. between the front and the back share : this implement offers very strong resistance, a great advantage in tearing through overgrown red fescue. The cultivator is attached to a tractor and can be regulated from the latter. A medium heavy seed harrow is attached to the cultivator. The better the cultivation after the seed harvest and in the early autumn, the higher is seed yield. Densely matted stands deteriorate greatly in seed formation and finally fail entirely. From the second year onwards heavy dressings of potassium (100 to 120 kg. per hectare), phosphates (60 to 80 kg. per hectare) and nitrogen (50 to 80 kg. per hectare) must be applied. Red fescue responds very well also to an application of liquid and farmyard manure in summer after harvest or in the autumn.

Invading grasses such as ryegrass, cocksfoot, meadow fescue and brome grass should be eradicated in good time before harvesting. Maturity is reached approximately two or three weeks before the cereal harvest. The panicles become brownish yellow, with a reddish violet shading. The seeds are firmly attached to the panicle and the danger of loss through shedding is not so great as in the case of meadow fescue; red fescue may therefore be allowed to ripen well. Mowing, harvesting and threshing are done as in the case of meadow fescue. In threshing care must be taken that the seed is completely detached from the panicle ; it is occasionally necessary to thresh the crop twice. For final cleaning the use of a huller or brusher is required in order to separate double seeds from one another. The minimum purity of 95 per cent required for seed certification can easily be obtained ; germinability should amount to 90 per cent. Seed yield amounts on an average to 350 kg. per hectare ; it varies from 200 to 700 kg. per hectare.

The average production per hectare for all our seed growing centres with spring sowing, was, as follows :

| Harvest Year. | With a cover crop.                 |          |           | Without a cover crop.              |          |           |
|---------------|------------------------------------|----------|-----------|------------------------------------|----------|-----------|
|               | Number of seed production centres. | Seed kg. | Straw dz. | Number of seed production centres. | Seed kg. | Straw dz. |
| First .....   | 54                                 | 456      | 32.2      | 12                                 | 691      | 45.2      |
| Second .....  | 52                                 | 545      | 35.6      | 12                                 | 523      | 43.7      |
| Third .....   | 31                                 | 332      | 34.6      | 12                                 | 402      | 37.5      |
| Fourth .....  | 10                                 | 261      | 31.0      | 10                                 | 345      | 32.9      |
| Mean :        |                                    | 399      | 33.4      |                                    | 490      | 39.8      |

Sowing without a cover crop resulted in an average increase for the four years of approximately 100 kg. seed ; straw yield also is higher than when a cover crop is employed. In the cover crop series, yield is highest in the second harvest year. The best farm obtained the following seed yields for the four harvest years from a crop sown in spring without a cover crop : 886, 570, 422, and 221 kg. per hectare, with a total area of 3 hectares.

Diseases which occur frequently are *Claviceps purpurea*, *Epichloe typhina*, rust species and white ear, which often gains the mastery in old stands and destroys whole fields. [From "Der Grassamenbau" (Grass seed production) by K. Weller. Arb. Reichsnährstandes. Vol. 7. pp. 80-6. Berlin, 1936. *Herb. Abstr.* 6, 232. 1936].

**Red Fescue.**  
**(*Festuca rubra*.)****W. FAITHFUL.****New Zealand.**

THE production of seed of *Festuca rubra* var. *fallax* (Chewings fescue) in New Zealand is practically confined to the Waimea and Five Rivers districts of Southland. According to statistics, in 1934/35 there were 11,294 acres seeded, of which 10,497 acres were in Southland.

**TYPE OF SOIL AND COUNTRY.**

This seed is grown on extensive plains; the soil is generally light and shingly, of fairly low fertility and consequent low stock carrying capacity. Fescue seed production is the most remunerative line of production to farmers on this class of country.

**CLIMATE.**

The rainfall in the fescue-growing area is about 24 inches per annum, while the general climatic conditions are fairly extreme. The winter months are generally cold and very bleak and the summer hot and dry; during the latter season these plains are subject to very strong westerly gales, which make harvesting very difficult.

**SOWING AND EARLY TREATMENT.**

Fescue seed is generally sown broadcast at the rate of 20 lb. per acre; a nurse crop, usually rape or rape and turnips, is general, sowing being done in November or December. If on better-class land, sowing is done in September or October, with grain, the grain crop is cut and threshed and the stubble is grazed by sheep. When sown with rape and turnips, the area is fenced off in breaks, and grazed during the autumn and winter; in the following spring the young fescue provides a limited amount of grazing. (Although generally regarded as a comparatively poor grazing grass, young fescue growth is grazed readily by sheep, particularly in the early morning when there is dew on the leaf.) If the sward has not thickened up satisfactorily, the area is not used for seed but as a grazing block until the following October, when it is closed up as a seed crop.

**HARVESTING.**

Skill and good judgment are two essential requirements for the successful harvesting of this crop. Fescue is ready for the binder almost to the day. The first indication of maturity is a purple colour in the seed heads; when this is general and there is the least sign of the mature seed falling, when touched, no time must be lost as the seed sheds very easily. It is recognized that the block to be harvested must be cut and stooked within three days; sufficient binders must be used to do this, and stooking must be done immediately after the binder, to minimize loss of seed. Any hollows where ripening might be uneven are not cut with the main block, but are cut separately at the correct stage.

**THRESHING.**

The crop is allowed to dry out and mature in the stook and threshing is generally done from the stook. The time allowed for the crop in stook varies between 10 and 21 days, according to weather conditions during that period. Stooks are never disturbed unless it is absolutely essential, as every movement means loss of seed. If there is little chance of the crop being threshed out of stook, the fescue is stacked, but, as previously stated, the crop shakes very easily and every handling means loss of seed.

## CULTIVATION AND TOPDRESSING.

A seed crop is generally taken for three or four consecutive seasons; after this the fescue produces very little seed, and renovation by skim ploughing is necessary. This ploughing must be done as late in the winter as possible, and can be repeated four times. There is generally little or no seed produced in the first year after skim ploughing. The greatest drawback to this renovation is that it permits of the ingress of weeds, chiefly *Agrostis tenuis*, *A. stolonifera*, *Anthoxanthum odoratum*, *Hypochaeris radicata* and *Holcus lanatus*.

Given favourable climatic conditions, an application of sulphate of ammonia to fescue will give an economic increase in the seed crop. The application of phosphate appears to aggravate the ingress of undesirable species, from a seed production point of view.

## DRESSED SEED.

There is generally a ready export market for seed of high bushel weight, good colour (good fescue colour is steel blue) and of satisfactory purity and germination. The two most difficult impurities to remove during machine-dressing are sweet vernal (*Anthoxanthum odoratum*) and catsear (*Hypochaeris radicata*). Felts are used on the riddles to remove the sweet vernal, and the catsear is removed in cylinders and riddles.

An average yield of chewings fescue seed is in the vicinity of 150 to 170 lb. per acre.

In recent years (since prices have risen) the loss of vitality of the seed during transit has given exporters reason for concern. Extensive investigational work has been undertaken as regards harvesting, stook and stack threshing, and different methods of packing and storing during transit overseas. The most satisfactory results have been obtained from shipping by direct steamer in cool storage.

## FUNGIOUS DISEASES AND INSECT PESTS.

Fescue appears to be practically immune from insect and fungoid pests. However, very occasionally, during a particularly humid season with little or no wind, the crop is liable to be attacked by a stem rust, which forms a "collar" just below the seed head and checks the development of the seed. This attack is very infrequent and the disease has not been closely studied or control measures formulated.

**Brome Grass.**  
**(*Bromus inermis*.)**

**T. M. STEVENSON and**  
**L. E. KIRK.**

**Canada.**

BROME grass is grown more extensively than any other cultivated perennial grass in the Prairie Provinces of Canada, but is rarely found under cultivation in the more humid areas of Eastern Canada. Its hardiness, great vigor of growth and leafiness, together with high palatability and feeding value, make it popular as a hay and pasture grass. In drought resistance it is not the equal of crested wheat grass (*Agropyron cristatum*), but it will persist and produce reasonably well in all except the driest areas. It is grown satisfactorily on most soil types. Where sufficient moisture is available even the light sandy soils produce fair yields. Highest yields of both herbage and seed are obtained on the rich, dark clay loams, which are not seriously deficient in moisture.

Where grown primarily for seed production, brome grass is sown on land that is free from couch grass (*Agropyron repens*) and other native or cultivated plants, the seeds of which are difficult to separate from the brome grass seed. The crop is



usually sown with the grain seeder which places the seed in drills spaced six inches apart, but in areas where moisture conditions are more favourable the seed is sown broadcast, while in the drier areas it is usual to sow in rows spaced about three feet apart. Clean, firm summer fallow, or land which had produced an intertilled crop the previous year, and is relatively free from weeds, provides the most desirable soil preparation.

Where moisture conditions are favourable the grass is frequently sown with a nurse crop of oats, wheat or barley. The nurse crop is often harvested for hay and thus removed from the land long before it becomes mature. This practice enables the grass seedlings to develop into sturdy plants before cold weather sets in. Under conditions of very limited soil moisture the use of a nurse crop often seriously reduces the stand of grass. Where a nurse crop is sown the grass seeds are usually mixed with the seeds of the nurse crop and the two sown, in one operation, with the grain seeder. The grass seed alone does not flow evenly unless the seeder is equipped with a special agitator in the seed box.

The maximum depth of seeding for brome grass is 1.5 inches. When broadcast or sown in drills spaced six inches apart, about 14 pounds of seed are required per acre. For seedings made in rows spaced approximately three feet apart, only 3 to 4 lb. of seed per acre are sufficient to give a satisfactory stand.

When the grass is sown broadcast or in six-inch drills, without a nurse crop, weeds are usually controlled during the year of seeding by use of the mower. It is usual to adjust the mower so that it leaves a stubble of four to six inches, thus removing the seed-bearing parts of most of the weeds without injuring the grass greatly. Spécial shoes, which raise the cutting bar of the mower to any required height, are used. Several shallow cultivations, beginning as soon as the grass has emerged, are usually necessary to control weeds when the grass is sown in widely spaced rows. It is a common practice to graze the grass lightly in the fall of the year. During the year the crop is sown, grazing should not begin earlier than September 15. Light tillage given early in the spring of the second and succeeding years is beneficial. The drag harrows or disk harrows are commonly used for this purpose.

The seed crop is usually harvested during late July, although the time of harvest varies from mid-July to August 10, depending upon soil and climatic conditions. The stage of maturity of brome grass cannot be judged readily by the colour of the glumes, as can be done in many of our cultivated perennial grasses. Brome is extremely variable in this respect. In some plants the immature glumes are green and change to a deep brown at maturity. In many plants, however, the immature glumes are purplish and show only a slight change at maturity. The hardness or stiffness of the caryopses provides a convenient means of estimating the stage of maturity of the crop. When they become hard and fairly stiff the seed crop can be harvested. The seed does not shed readily when mature, although considerable loss may occur through heavy winds once the crop is ready to harvest.

The seed crop is harvested either with the grain binder or with the combine harvester-thresher. When the latter implement is used, it is necessary to allow the crop to stand until it is quite mature, since harvesting and threshing are done in one operation and the presence of green material among the seeds may cause damage through heating. When the grain binder is used the sheaves are usually made small, cured in a type of stook which permits of free air circulation, and threshed with the ordinary grain threshing machine.

Yields of dressed seed vary with the age of the stand and with climatic and soil conditions. Yields varying from 100 to 400 pounds per acre have been obtained. Usually not more than two or three remunerative crops are obtained from broadcast seedings or from seedings in drills spaced six inches apart. Widely spaced rows

usually remain productive for somewhat longer periods and the seed yields are less affected by dry weather.

During periods of severe outbreaks of cutworms or of grasshoppers, young seedlings of brome grass are occasionally destroyed. Older stands are affected little by these pests, but grasshoppers sometimes attack the panicles of the grass and greatly reduce seed yields. Little loss occurs from fungous diseases. Ergot (*Claviceps purpurea*) occurs occasionally, but usually is of little consequence so far as reduction in yield is concerned.

**Crested Wheat Grass.  
(*Agropyron cristatum*.)**

**T. M. STEVENSON  
and L. E. KIRK.**

**Canada.**

CRESTED wheat grass has recently become important as a hay and pasture plant and for reseeded range lands in the drier prairie areas of western Canada. It is a long-lived perennial bunch grass which is capable of surviving prolonged periods of drought without injury and possesses extreme winter hardiness. It is adapted to a wide range of soil types from light sandy loams to heavy clays, but produces best on the rich dark clay loams. The "Fairway" variety is preferred, because of its fine-stemmed, leafy habit of growth and also because it produces a denser turf than other available strains.

When grown primarily for seed production, crested wheat grass is usually sown in rows spaced about three feet apart. This method has consistently produced higher seed yields than broadcast or normal drilled seedings under conditions of limited soil moisture, such as exist over a large part of the prairie plains. It has the added advantage also of being easily inspected for off-type plants, which is an important feature in pure seed production of a registered variety.

Most satisfactory results are obtained from seedings made on clean summer-fallow or following intertilled crops such as potatoes or maize. In areas where lack of soil moisture is the chief limiting factor, best results are obtained when no nurse crop is sown, but under more favourable moisture conditions nurse crops of wheat, oats and barley are used successfully. Where the land is heavily infested with annual weeds, unless the crop is grown in intertilled rows, the use of a nurse crop is beneficial, since it helps to control weed growth and usually will not draw upon the soil moisture more heavily than will a heavy growth of weeds. When the grass is seeded without a nurse crop, weeds are prevented from maturing seed by cutting them back with a field mower.

From 2 to 4 pounds of seed are required per acre when the widely spaced row method of seeding is practised, whereas from 12 to 15 pounds of seed are required per acre for broadcast seedings. The depth of seeding is important. The young seedlings will rarely emerge if covered by more than 0.75 inch of soil. Thorough packing of the land prior to seeding is the general practice since such treatment helps to avoid deep seeding.

Crested wheat grass grows best under cool conditions and the young seedlings may be severely injured by dry hot weather, although when once established the plants are extremely drought resistant. The general practice, therefore, is to sow the crop early in the spring or in the autumn of the year so that the young seedlings will have a period of relatively cool weather in which to become established. The crop is usually sown with the ordinary grain drill. Special agitators are available which may be used to keep the seed flowing evenly through the seed outlets of the drill. If the drill is not equipped with such an agitator, a regular flow of seed may be obtained by mixing the grass seed with some heavier material. Wheat is commonly

used for this purpose, being first subjected to a heat treatment to prevent it from germinating; or it may be coarsely cracked and sifted. Approximately three pounds of wheat are mixed with one pound of grass seed.

If sown in widely spaced rows without a nurse crop, cultivation of the spaces as soon as the rows can be seen is necessary to keep down weed growth. Such cultivation must be shallow and frequent enough to prevent all growth between the rows.

The seed crop must be harvested as soon as the seeds are ripe, usually in late July or early August. Delayed harvesting often results in heavy losses of seed, since the plant normally sheds its seeds readily as soon as they become mature. In determining the proper stage at which to harvest the seed crop, both the colour of the glumes, and the hardness or brittleness of the caryopsis should be observed. When most of the spikelets have acquired a yellowish colour and the caryopses appear full and fairly stiff when pressed endwise between the thumb and forefinger, but are not yet hard and brittle, the crop is ready to harvest. At this stage a few seeds will have fallen to the ground.

Harvesting is usually accomplished by the use of the ordinary grain binder. When harvesting a crop grown in spaced rows, the plants frequently lie flat on the ground, due to the weight of the seeds in the heads at that time. The use of special extension guards on the binder enables such material to be raised and cut without difficulty. When the mature crop is very dry some seed will be lost in the harvesting process. The loss from shattering can be minimized by cutting early in the morning while there is still a slight dampness on the grass.

The seed crop normally is left in stook for from seven to twenty-one days before threshing. The dried material sheds its seeds readily and much seed may be lost if the floor of the sheaf rack is not tight. A common practice is to spread a tarpaulin over the floor of the sheaf rack before loading the sheaves.

Threshing is normally done with the ordinary grain thresher from which all concave teeth have been removed.

Seed yields of from 175 to 800 pounds per acre have been obtained from crops grown in widely spaced rows. When the grass crop is sown with a nurse crop of cereals, the second crop of grass seed is usually heavier than the first. When sown without a nurse crop on clean soil, the first crop is normally the heaviest and the yield drops markedly on the second and each subsequent crop harvested. It is not usually profitable to harvest more than three or four seed crops from a field seeded in inter-tilled rows, or two crops when the seeding has been made in six-inch drills.

During the past few years much damage has been done by grasshoppers in areas where severe outbreaks of this pest occurred, and the young seedlings are sometimes destroyed by cutworms. Of the plant diseases common to most perennial grasses, ergot is the only one which has appeared on crested wheat grass, and it has caused practically no damage to date.

**Crested Wheat Grass.**  
**(*Agropyron cristatum*.)**

**LEROY MOOMAW.**

**United States  
of America.**

CRESTED wheat grass seed production in the United States has been on a commercial basis for less than 10 years. The amount of seed produced has increased from less than 5,000 pounds in 1925 to 500,000 pounds in 1935. Due to the drought, production in 1936 was less than half that in 1935. The acreage of this grass has increased so much that a crop of over a million pounds of seed may be expected when normal weather conditions return to the producing areas.



Most of the seed is grown in the Northern Great Plains and in the dry-land parts of the Pacific Northwest, usually in areas having 12 to 18 inches of annual rainfall. North Dakota, Montana and Oregon lead in production and probably will continue to do so. Some seed has been grown in South Dakota, Wyoming, Colorado, Washington, Idaho, Nebraska, Utah, California and Kansas.

Yields of crested wheat grass seed in the United States vary from an average of 200 to 300 pounds per acre on dry land up to 1,000 pounds per acre under irrigation. In drought years the seed crop may be a total failure on dry land, while in good years yields may run up to 500 to 600 pounds per acre. An ample water supply and cool weather during the growing season are factors which favour seed production.

Much of the seed has been grown in rows planted 36 to 42 inches apart and cultivated two or three times each season. This method results in higher seed yields in some seasons and usually produces a higher quality of seed than close-drilled plantings. Since crested wheat grass is primarily a pasture and range grass, it seems likely that after it becomes widely distributed most of the seed will be harvested from solid stands where the crop will be pastured in unfavourable years and harvested for seed in good years.

The crop is well adapted to this practice since it produces heavy yields of seed in good years, and a surplus of seed can be carried over to unfavourable years. As viability of the seed remains high for several years, it can be safely carried over.

Most of the crested wheat grass seed is harvested with the grain binder, although the header, combine or harvester-thresher, and mower are also used. The binder is usually started before the seed is thoroughly ripe, at the time when the very earliest heads begin to shatter. Seed in the tough dough stage of maturity can be safely harvested. The bound grass is placed in shocks of 12 to 16 bundles as soon as cut and left to cure for about 10 days before threshing.

The small-grain header is used to good advantage in cutting crested wheat grass, when seed is fairly mature. The heads are placed in long, narrow stacks for about three weeks before threshing. Crested wheat grass harvested with a header threshes easily and rapidly, and the seed as it comes from the thresher is usually cleaner than that from a crop harvested with a binder or combine.

Best results with the combine are obtained by cutting with a swather or windrower while the seed is slightly green. After curing for three or four days in the windrow, the pickup is used and the seed run through the combine. Some seed is lost when the pickup lifts the swath, but the loss is probably less than that from handling bundles of shocked grass. This method cannot be used for harvesting cultivated rows, for the swath or windrow will settle down between the rows and cannot be recovered by the pickup equipment.

Direct threshing of crested wheat grass with a combine is usually unsafe and is done only in very dry seasons or in districts having no summer rainfall. As a rule, stems of crested wheat grass are green when the seed is ripe, and if recent rains have fallen there will be a few green heads with the ripe ones. This green material is heavy and cannot be completely separated from the seed. A small amount of such green, wet material causes heating of the seed if piled in a bin. Seed threshed with a combine must be run over a cleaner at once to remove green material before the seed has had time to heat. Unless mechanical equipment is available for cleaning the seed rapidly, or there is ample space to spread the seed for drying, the use of the combine may result in seed of low germination. A better plan is to cut the grass with binder, header, or mower, and thresh after it has dried.

Crested wheat grass seed is readily threshed with the small-grain thresher after adjusting so that the seed is all removed from the straw and is not blown away. As a rule the cylinder is run at about the same speed as for small grains, but the

opening to the fan beneath the screens should be closed almost completely at first, then adjusted so as to clean the seed properly without blowing it away.

Crested wheat grass bundles are fed into the machine only about half as fast as small-grain bundles. Too rapid feeding may result in the straw clogging up the machine.

Crested wheat grass seed is cleaned by running it through a fanning mill once or twice and then through an indent disk type of cleaner to remove small weed seeds, bits of stem and straw, and other foreign matter.

Prices paid to growers of crested wheat grass seed have varied from 20 to 40 cents per pound during the past few years, these reflecting the short supplies and heavy demand of new seed growers and for seeding pastures, ranges and land taken over by Government agencies. As soon as one or two normal crops are produced, the price probably will come down in line with that of brome grass, which usually sells at 5 to 10 cents per pound to the grower.

**Slender Wheat Grass.  
(*Agropyron pauciflorum*.)**

**T. M. STEVENSON  
and L. E. KIRK.**

**Canada.**

THE production of slender wheat grass in Canada is confined largely to the three prairie provinces. It is a short-lived perennial bunch grass, which possesses great hardiness and thrives on land which contains concentrations of alkali salts too high to permit the production of cereal crops and other cultivated perennial grasses. In drought resistance it is exceeded only by crested wheat grass and brome grass. In new seedings it grows rapidly and quickly becomes established. As a hay and pasture grass it is of greatest value in mixtures with the longer-lived grasses and with legumes. Several varieties and strains are available, but Mecca, Grazier and Fyra are most widely grown.

In the production of seed it is usual to sow slender wheat grass in drills spaced six inches apart or broadcast. Plants sown in widely spaced rows often continue to tiller after the earlier culms are almost mature so that there are many immature spikes at harvest time and the quality of the seed is often greatly reduced due to the presence of green coloured seeds in the sample.

Freedom from couch grass (*Agropyron repens*) and other grasses, the seeds of which are difficult to separate from those of slender wheat grass, is the first consideration in choosing land for seed production. Slender wheat grass competes relatively poorly with weeds and is grown most successfully on clean summerfallow, corn or potato land, or where moisture conditions are favourable on clean stubble land. The crop is generally sown with a nurse crop of wheat, oats or barley. The nurse crop is usually sown at a rate equal to about one-half of the normal rate for the crop when it is grown alone; it is often harvested for hay at an immature stage and thus removed from the land early in the season in order to give the grass crop a better chance to become established.

The grass is normally sown with the grain drill. If the seed is fairly heavy and free from trash, it will flow through the seed outlets freely. When a cereal nurse crop is used the cereal and grass seeds are mixed and sown in one operation. The seeds are usually covered to a depth of about two inches. The fact that young seedlings of slender wheat grass will emerge from such depths makes it suitable for seeding with cereals which can be sown satisfactorily at about the same depth. In close drilled or in broadcast seedings, approximately 14 pounds of seed are required to sow one acre. In widely spaced rows, about 4 pounds are used.

When sown in close drills or broadcast without a nurse crop, the control of weeds, during the year of seeding, is accomplished through the use of the mower. Seedings made in widely spaced rows usually require several shallow cultivations during the year of seeding to control annual weeds. Light autumn grazing, beginning not earlier than the end of September, is practised.

The seed crop is normally harvested in late July or early August after the spikes have taken on a bright straw colour. The seeds are shed fairly readily after full maturity and usually a few seeds have fallen to the ground by the time the crop is ready to harvest. Harvesting is normally accomplished by use of the grain binder and the sheaves are set up in a well-ventilated type of stook and allowed to cure for from 7 to 15 days before being threshed. A grain-threshing machine is used for this purpose. The combine harvester-thresher is also used for harvesting the seed crop, but since the grass must be allowed to stand until quite mature before it can be harvested by this method, there is danger of much of the seed being shed and consequently of the yield being greatly reduced.

Seed yields range from 100 to 400 pounds per acre. A fair average would be about 250 pounds per acre.

Some damage frequently is caused by the wheat stem sawfly (*Cephus cinctus*), but normally this pest does not reduce yields greatly. Smut of slender wheat grass, caused by *Ustilago bromivora*, occurs frequently but usually does not seriously reduce yields. This smut can be controlled by seed treatment with formaldehyde. The grass is also subject to attack by certain root-rot organisms, including *Ophiobolus graminis* and *Helminthosporium sativum*, which tend to reduce yields of older stands.

### **Crested Dogtail. (*Cynosurus cristatus*.)**

**S. P. MERCER.**

**Northern Ireland.**

CRESTED dogtail seed is produced on the kindlier type of loamy soil, in a fairly well defined area of roughly circular outline some ten miles across, in the centre of the County Down. The forty-inch rainfall dispersed throughout the year provides a suitable climate for *Cynosurus*, which enjoys fairly humid conditions so long as drainage is good. If kept too wet underfoot, it is liable to exhibit vivipary.

The two chief difficulties attending the industry are liability to wet weather at harvest time, and very low value of the threshed straw. Bad harvest weather naturally affects quality (germination capacity) to some extent, but chiefly it destroys appearance. In a good season excellent seed is gathered. In a wet summer the product is still good, by reason of the care taken in "saving" the crop, but the bright yellow colour of the flowering glume is very easily lost and browned seed competes with difficulty in the market against a bright golden sample, even if the two are alike in viability. The consumption of dogtail straw has always been something of a problem. Half a century ago there was a market for it in the Luton district where it was largely used in the form of straw plait for bonnets. But straw bonnets are no longer worn and the straw is now unsaleable. It may be consumed at home, but is very inferior fodder by reason of its hard and fibrous character. Tentative trials of retting in the hope of separating a fabricable fibre have not been successful.

Dogtail seed being relatively small, the weight necessary to sow an acre is correspondingly low; the standard acre seeding is 20 lb., about 900,000 seeds. It is broadcast from a "fiddle" in April or early May with an oat nurse crop. It makes little growth during the summer or autumn of the seeding year and cannot normally



be grazed. Indeed under ordinary lowland conditions, on good land, dogstail is an unprofitable grazing subject at any time. It is not included in mixtures for hay and/or pasture in this area, although it invariably appears as a volunteer in the later years of our leys, and sometimes to a very prominent extent on the poorer soils. In the seed-producing district it is not retained after harvest for pasture, as is perennial ryegrass, and hence it is sown "pure." The crop responds to manuring and commonly receives a dressing of nitrogen and phosphate, to which potash is added on the lighter soils.

The first seed crop is light, the plant not yet having reached maturity or tillered fully; about 4.5 cwt. of seed may usually be gathered from this cut. It is retained for a second year when a heavier crop is borne, amounting to some 6 cwt. and ranging up to seven. A further dressing of nitrogen, without other manures, is given in the spring of the second harvest year. The ley is not retained longer than two years since it begins to become "dirty" with volunteer species, subsequent seed yields fall and, moreover, the sward does not offer any material grazing.

Ripeness is judged by colour of the seed husk. A properly ripened "seed" is usually described as "bright golden yellow," and while the greenish tinge remaining at harvest justified this description, a few days maturing makes "mustard yellow" more accurate. Harvest ripeness is usually attained about mid-August and at this period broken weather is liable to be encountered. The bright colour is easily injured by weathering and may be lost without any serious harm accruing to the seed. Fortunately, dogstail does not shatter easily even when ripe so that a reasonable latitude in choosing cutting date is available and poor weather conditions can sometimes be circumvented. Discoloured seed turns brown.

After reaping by machine and hand-tying, the crop is set up in very small stooks of four sheaves each and there remains, according to weather, for from one to two weeks. Subsequently the stooks are built into small "ricks" in the field, heads inwards, about thirty stooks going to a six-hundredweight rick. Threshing is commonly completed early in autumn (say by the end of October) by means of the travelling thresher and the seed appears on the wholesale market during the early months of the winter. Sale to wholesale machiners is conducted upon sample in the country markets in the same way as the sale of ryegrass, and the produce is subsequently delivered to machiners' warehouses for cleaning and bulking before February.

Prices vary very widely from season to season and during the three years 1933-1935 touched the limits of £3 and £8 per hundredweight. Within a given winter the price may fluctuate over a range of about thirty shillings.

The weed species typical of dogstail seed are rather more numerous (because smaller) than those of ryegrass. The most prominent are "shelled" seeds of *Holcus lanatus*, small grains of *Festuca scurroides*, *Crepis virens*, *Hypochaeris radicata*, *Poa annua*, *Alopecurus geniculatus* and *Aira carophyllea*.

Disease does not give noticeable trouble: a few sclerotia of small ergot will occur in most threshings, but are not of serious account and are removed in machining. The finished sample may be expected to show an analytical purity of 96 to 97 per cent and a germination in a good season of 90 or over.

**Agrostis Species.****H. A. SCHOTH and  
H. F. A. NORTH.\*****United States  
of America.**

SEVERAL thousand acres of various species of *Agrostis* are harvested in the Pacific Northwest each year for seed. These species include *A. palustris* (seaside bent),† *A. tenuis astoriana* (Astoria bent), *A. tenuis oregonensis* (Highland bent), and *A. tenuis* (Colonial bent).

Most of the *Agrostis palustris* is harvested in southwestern Oregon, with smaller lots harvested in various Puget Sound sections and in the Klamath Falls country of south-central Oregon.

Practically all the Astoria bent comes from the lower Columbia River district in Oregon and Washington.

The large majority of the Highland bent comes from various sections of the Willamette valley, with smaller amounts from the north Umpqua region, mostly in the vicinity of Yoncalla, Oregon.

Most of the Colonial bent of the Pacific Northwest comes from various sections in western Washington, such as the Chehalis River Valley and a few areas in the vicinity of Puyallup.

The season of harvesting and threshing usually occurs from August 10 to September 20 and occasionally extends to October 1, depending upon seasonal conditions. Quite often when early autumn rains occur, the cut material, if it can be properly dried, is stored in sheds or barns and threshed as opportunity offers.

The material to be harvested for seed is cut when not less than 75 per cent of the seeds are ripe and preferably when more than 90 per cent of the seeds are ripe. Bent grasses shatter comparatively little except under extremely adverse conditions, such as may develop because of alternating periods of rainy weather and warm dry weather, accompanied by considerable wind.

Most of the field harvesting is done with the ordinary mowing machine. Swathers are quite often used, and occasionally where stands are rather thin, bunching attachments on the mowing machines are also used. Some harvesters do not use attachments, but bunch the cut material with either a jump rake or a side delivery rake. The jump rake is more satisfactory than the side delivery as it results in less handling of the cut material and if there is any tendency to shatter, reduces it to some extent. As soon as the cut material is dry enough to shock, it is put in medium-sized shocks. This is done largely for the purpose of increasing the rapidity of curing. Large shocks cure out rather slowly, particularly as there may be a tendency to dampness under the climatic conditions that commonly prevail in the *Agrostis* growing districts.

Some hand harvesting is also done. This usually occurs where stands are comparatively thin or are rather badly mixed. Such harvesting is usually done with sickles and the heads are removed with as little straw as possible. The heads are piled on sheets or canvas and usually are removed as soon as dry to a place of storage previous to threshing.

Practically all the threshing is done with the ordinary grain thresher. Threshing bent grass for seed requires very close supervision of operations to obtain all the seed from the heads and straw and still not blow it over into the straw pile. This usually results in a large amount of foreign material being put into the seed bag.

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\*H. A. Schoth, Divn. of Forage Crops and Diseases, Bureau of Plant Industry, has prepared the part covering bent grass seed production in the Pacific Northwest, and H. F. A. North, of the U.S. Golf Association, the part covering production of Colonial bent in Rhode Island.

† The form of this species grown in Oregon is called seaside bent. The form grown in Rhode Island is called creeping bent.

Many *Agrostis* seed threshers consider that if they obtain from 10 to 20 pounds of seed per bag, they have done a rather good job and have lost comparatively little seed. The remaining material in the bag is chaff, straw, etc., which is generally comparatively easy to remove in the cleaning operation. Threshing should not be done until the material is thoroughly dry.

Two types of cleaning machines are generally used, a third being occasionally brought into use. Most of the cleaning is done with the ordinary three-screen machine. Quite often some preliminary cleaning is done with a scalper, which removes the coarse material previous to running it through the screen machine. Occasionally the vibrator type of machine is used on lots of seed that are particularly difficult to clean.

Practically all the high-grade *Agrostis* seed, particularly of fine bent grasses, is certified by State agencies both in Washington and Oregon. Such certification is based on very definite standards and is carried on both in the field and with re-cleaned seed.

The total production of bent grass seed in the Pacific Northwest in 1935 has been estimated at more than 600,000 lb.

There is a very small amount of redtop seed harvested in the Pacific Northwest in some years. This grass for seed is usually cut with a grain binder and threshed when dry with the grain thresher. Cleaning is the same as for bent grasses. No certification is done.

#### HARVESTING FINE BENT SEED IN RHODE ISLAND.

At present the harvest of fine bent seed in Rhode Island consists of Colonial bent (*Agrostis tenuis*), velvet bent (*Agrostis canina*), and creeping bent\* (*Agrostis palustris*). The bulk of the crop is colonial (Rhode Island) bent, which also may contain small amounts of velvet and creeping bent. On unlimed soils it is unusual to find redtop in appreciable amounts.

The growth of creeping bent has declined in recent years to the extent that only small amounts of the Narragansett strain are now harvested.

Considerable attention is being given by several growers to the possibilities of No. 14276 and other velvet bents as seed crops. Not more than 50 acres of the No. 14276 and the Kernwood strains were harvested in 1936. Should the growing of these velvet bents prove practicable, very probably much larger areas will be planted in the future. An effort has been made by the Rhode Island Experiment Station to encourage each of the growers to maintain a small area free from mixture, from which seed can be harvested for the planting of new areas in order to prevent the encroachment of colonial bent which is somewhat more aggressive under seed production.

The harvesting of bent seed has mainly been confined to the southeastern quarter of the state and to planted fields rather than to the more or less naturalized area such as reverting meadows, old pastures and the like. It has been found that in Rhode Island, as a rule, a meadow brought into a high state of fertility and planted with such crops as timothy and clover will, when neglected, gradually change in flora through *Poa pratensis*, colonial bent, *Danthonia spicata* and weeds to bushes and forests. Rather marked changes in this respect were found to occur during a period of five years between plots well fertilized and those that were very slightly fertilized.

Harvesting is usually completed during the period from July 15 to August 1.

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\*The form of this species grown in Oregon is called seaside bent. The form grown in Rhode Island is called creeping bent.



It has been found that practically all the seed of velvet bent will shatter out unless it is cut promptly. The colonial and creeping bents seem to retain their seeds somewhat longer under the same conditions although considerable amounts are lost even in these species. The proportion of seed which is lost by shattering is not definitely known. Bent grasses are usually harvested before there is any appreciable yellowing or bleaching of the culms or heads and before the seeds in the lower part of the panicles are quite mature.

The bent grass is cut with mowing machines, cured partially in the swath, and windrowed with jump or side delivery rakes. Although final curing in shock after one day in the swath would probably lower the loss by shattering, it is not a customary practice and the dried grass is usually loaded on trucks or wagons directly from the windrow and taken to the stack or loft for storage.

Threshing is begun after the grass becomes dry in storage, usually in mid-autumn. Facilities for threshing small lots of particular strains are provided by the Experiment Station in order to prevent mixture with other bents and the larger amounts are threshed with ordinary grain threshers, without the air stacker. Even with fine sieves in the machines a large amount of hay, leaves and broken pieces of the panicles falls through with the seeds. Under ordinary conditions an appreciable amount of seed remains in the straw and on occasion some growers have threshed the grass a second time. Tests by the Experiment Station have indicated that the recovery on the second threshing is rather small, and unless the seed is selling at higher than average prices re-threshing is probably not justifiable. The seed is more readily removed when the grass is relatively well matured, cured without having been wet by rain and well dried. It is probable also that under these conditions the threshed seed is diluted with a minimum of foreign material.

Although some of the Rhode Island colonial bent is riddled by hand to remove the coarser material, the larger part is machine scalped in preparation for final cleaning. The ordinary fanning mill has proven rather too slow for the cleaning of bent even when motor driven. The highly refined and moderate to large sized combination air and screen machines are used for cleaning the greater part of the crop. The cleaning is necessarily a delicate process since the chance of loss is high and small weed seeds, pieces of vegetation, sand and dust must be removed. Chickweed seed is larger in diameter and single rush seeds are smaller than the bent. Major plantain and spring dandelion are rather uncommon and yarrow is not usually abundant in the unlimed or lightly limed fields harvested for seed. Chickweed, rush and yarrow are the most difficult seeds to remove.

If the grass is not fertilized, yields of colonial bent are usually low after the first and second crop years. Experimental and practical results indicate, however, that these low yields can usually be doubled or trebled by proper fertilization. The yield of the more desirable velvet bents was found to continue over a period of years at a relatively stable level considerably below that of colonial bent. Under the same conditions creeping bents yielded fairly well, but died out almost completely after two crop years. Colonial bent yields from experimental plats declined during a period of five crop years more rapidly than velvet bent although good stands of both remained at the end of that period.

Under the conditions at the Rhode Island Experiment Station it was found that a maintenance fertilizer to promote a good harvest for colonial bent seed should approximate the ratio of 6-2-1 (NPK).

The certification of bent seed except for variety has not been instituted in Rhode Island. In general the seed is cleaned satisfactorily and is otherwise of good quality.

Experimental results at the Rhode Island Station on bent seed production are largely summarized in the following publications although work is in progress on

the breeding of velvet and colonial bent grasses for greater seed yield, and on the fertilizers suitable for the production of bent grass seed.

1. RHODE ISLAND Agricultural Experiment Station, Bull. 245. Putting green grasses and their management. By H. F. A. North and T. E. Odland. 1934. pp. 44.
2. NORTH, H. F. A., and ODLAND, T. E. Seed yields of Rhode Island colonial bent (*Agrostis tenuis* Sibth.) as influenced by the kind of fertilizer applied. *J. Amer. Soc. Agron.* 26. 939-45. 1934.
3. ———— The relative seed yields in different species and varieties of bent grass. *J. Amer. Soc. Agron.* 27. 374-83. 1935.
4. ODLAND, T. E. Bent grass seed production in Rhode Island. *Bull. U.S. Golf. Ass. Green Sect.* 10. 201-4. 1930.

### Browntop. (*Agrostis tenuis*.)

J. O. WALLACE.

New Zealand.

THE genus *Agrostis* is a complex group and over a hundred species have been recorded. Eight indigenous and four naturalized species are located in New Zealand. Some of them are, however, by no means common, being restricted to limited habitats, and again, differentiation between some species is most difficult. For general purposes it can be said that there are three distinct and fairly easily recognizable economic agricultural species in this country. They are:—

- (1) Browntop (*A. tenuis*).
- (2) Redtop (*A. palustris*).
- (3) Creeping bent (*A. stolonifera*).

Of the three, browntop is of the greatest economic importance. It is a native of Europe and is now abundantly naturalized in New Zealand.

Browntop is capable of adapting itself to various soil types. At the present time it is to be found in both the North and South Islands and it occurs on the better-class gum lands of North Auckland, on heavy land of Wairarapa, Manawatu, Westland, South Otago and Southland, with a belt running along the foothills to the Alps in Canterbury. It is found on country ranging in altitude from sea level to 3,000 feet.

The soils which form its natural habitat are of the poorer second-class order. It will flourish on soil of a higher order, but on the latter type it is not considered a good grazing proposition and consequently not appreciated in the eyes of the stock man.

The greater part of the seed harvested is taken from the rolling country of South Otago, while Southland and the foothill country of Canterbury contribute the remainder of the seed for the commercial markets.

The grass adapts itself to varying conditions both as regards soil and moisture. In localities where it dominates naturally and is harvested for seed, the annual rainfall varies from 28 to 36 inches.

#### SOWING.

In the seed-producing localities browntop seed is rarely, if ever, sown. In these districts, mixed farming with a strong trend to dominance by sheep on the pure browntop country, is the main agricultural calling. A good portion of such a farm is kept under the plough in supplying supplementary and root crops. These areas are ultimately sown to English grasses, but as they age the sown grasses weaken and die out and in a period of from four to five years from time of sowing, according to management, browntop makes a strong natural ingress and in a short period is the

dominant species in the field. It is these fields that supply the greater quantity of seed entering the market.

#### MANURING.

Dominant browntop areas are rarely, if ever, topdressed. On some of the slightly higher types of soil when the browntop is associated with white clover and a sprinkling of other grasses, topdressing with carbonate of lime to encourage the clover growth is occasionally carried out, but such practice is by no means common.

#### GRAZING.

Pure browntop pasture as a grazing proposition has its limitations ; its carrying capacity is low, and on farms in localities where the grass rapidly takes possession, large areas are kept under the plough to supply supplementary forage and winter roots.

#### HARVESTING.

The greater part of the seed is harvested by contractors on agreement with the owners of the fields, the general basis of the agreement being a division of the seed or of the cheque obtained. Harvesting normally extends over a fairly long period commencing in late February and carrying through to April. The stripping machine is almost universally used to collect the seed. Occasionally the crop is cut with the mowing machine and raked immediately into windrows, where it is allowed to dry out. It is then picked up by sweep and taken direct to the mill or put into stook for later threshing. In the Clydevale country, where it grows to perfection if closed early, it is occasionally cut with the reaper and binder and treated similarly to ryegrass seed. Only when prices are exceptionally high and the crop very heavy is harvesting by the stripper departed from. The general opinion is that although probably more seed is gathered, the extra expense involved in stooking, threshing, etc., offsets the extra revenue obtained by way of sales of greater quantities of seed.

The stripping method is most economical as the machine can be operated by a youth with two to three horses, depending on the class of country. At convenient places in the fields being stripped, the seed gathered in the stripping machines is emptied at intervals on sheets and then loosely bagged. The seed is generally allowed to stand in the bags under shelter to allow it to harden. A fair amount of straw is collected during the stripping operations, but this is removed on the farms with riddles before the seed is forwarded to the commercial machine-dressing plants for cleaning. Cleaning is carried out by passing the seed over a series of riddles and revolving cylinders. Only plants with special equipment are capable of handling the dressing of this seed, which is probably the smallest occurring in general agricultural practice. Browntop does not shake or shed its seed readily and if bright dry days are not experienced during stripping, the fields are often subjected to double stripping. High winds accompanied by a battering rain, following a month or more of abnormal dryness, can, however, cause a severe loss of seed. This condition and a sharp frost when the plants are in flower (late January) are the only climatic conditions feared by the person looking forward to the harvesting of browntop seed. The crop ripens uniformly and harvesting commences when the seed can be fairly readily separated by rubbing the heads of the seed stalks in the palm of the hand. Another general method of testing to ascertain the harvesting stage is to apply the hat test. By this a hat is swept through the standing seed heads with a sweep of the hand, and if seed is readily gathered it is a good indication that stripping could commence.

In its natural habitat browntop persists and continues seeding for a number of years without any special treatment. It is, however, inclined to become sod-bound



on the extra heavy and poorest types of soil. When this does occur the field has reached the stage to be ploughed up and utilized for oat or forage crop production.

As no specialized attempt at seed production or special care of areas for such purposes is made, little or no thought is given to loss caused by fungous or insect pests. Probably as it is a late autumn or early winter seeding grass, fungous and insect pests in particular cause practically no apparent loss. Small patches in fields are occasionally affected by either a smut or ergot, but such infection is comparatively rare.

Yields of browntop seed vary considerably, but in general are comparatively low. The practice is often adopted of stripping only those portions of the field which are carrying a good seed crop, so that actual yields are difficult to determine.

The revenue obtained from the harvesting of browntop seed is looked upon as "extra money" by the general farmer. The market price fluctuates widely through the year and from year to year. It has fluctuated from 6d. to 2/9d. a pound in a year. A great part of the seed is taken from fields that grew too fast for stock in the summer and only when prospects for a good market seem bright are fields specially closed to stock to allow of full seed production.

The seed normally is of very high germination, very seldom lower than 95 per cent. It carries well and no special shipping precautions are taken as it appears to retain its germination under varying conveying conditions.

**Kentucky Bluegrass.  
(*Poa pratensis*).**

**A. J. PIETERS.**

**United States  
of America.**

KENTUCKY bluegrass seed is produced mainly in two districts, one in Kentucky, about thirty miles around the city of Lexington, and the other in what is known as the "Western" district covering north-west Missouri, parts of eastern Kansas and Nebraska, and southern Iowa. A small amount is also produced in Illinois and occasionally in Minnesota, South Dakota and Ohio. The average annual production in the Kentucky district for the 11 years 1920 to 1935 was about 820,000 bushels of rough-cured seed weighing probably about 10 to 12 pounds per bushel. During this same period the Western district produced 960,000 bushels. Between 1920 and 1926 production was generally larger in the Kentucky than in the Western district, but since 1927 the reverse has been the case.

The yield per acre has fluctuated between 3 and 7 bushels rough-cured, generally 4.5 to 6 bushels. Yields have generally been a little higher in the Kentucky than in the Western district.

Seed is taken from permanent pastures. Some of those in the Kentucky district are said never to have been plowed, and nearly all are of long standing. When seed is wanted stock are kept off until after seed harvest, or the field may be grazed a short time in early spring. Seed is ripe during June, earlier in Kentucky than in the Western district, and maturity is indicated by the browning of the panicles. Formerly harvesting was done with comb strippers drawn by horses. The grass culms slipped into the slots and the seed was stripped from the panicle. These, as well as hand strippers of the same type, are still in use for small scale operations, but the bulk of the crop is now harvested with a rotary stripper. There are two types. In the one used in Kentucky the principle of stripping is the same but the new machine has three combs on a skeleton cylinder. As the machine moves forward the cylinder rotates and each comb moves into the grass as the preceding comb withdraws. The seed stripped by each comb is pushed off by means of a bar at the top of the cylinder

on to an apron elevator by which it is carried into a box. As many as three of these machines can be drawn by a tractor.

In the Western district the machine commonly used is a rotary stripper consisting of a 16-slat cylinder in which the slats are armed with rows of special spikes, those on adjacent slats being staggered. The cylinder is mounted on a frame and revolves rapidly, the spikes knocking the seeds from the panicles and throwing them into a box at the rear of the machine.

In both districts but more especially in the Western district the harvesting machines are owned by large operators who lease acreage or pay the owner an agreed price for the rough-cured seed. The operator then does the work of harvesting and curing.

The "rough green" seed is piled in low ricks for curing. Side delivery rakes are used to turn the ricks and thus prevent heating. Heating reduces the vitality of the seed and the low percentage of germination sometimes shown by fresh seed is nearly always due to overheating in the curing process. When the fields in Missouri are foul with timothy the bluegrass is harvested on the green side. In this case extra care must be taken to avoid heating but this is cheaper than to clean out the ripe timothy. When cured the seed is known as "rough dry" and is taken to special mills where it is rubbed, cleaned, and graded. The grades of clean seed most common on the market weigh 15, 17, 23 and 25 pounds per measured bushel but 19 and 21 grades can be had. A rough average of rough green to clean seed is about two to one.

**Meadow Foxtail.**  
**(*Alopecurus pratensis*.)**

**K. WELLER.**

**Germany.**

THIS grass is seldom grown for seed in Germany. It is more usual to collect by stripping the seed from natural grassland and fertile valleys, where it often composes the sward. The seed ripens irregularly; if not collected with care and understanding, a large proportion may be unripe and germination capacity in consequence may be very low. This kind of seed production is only practicable when labour is cheap; one workwoman can collect from three to four kg. seed per day by stripping.

Only good, fresh, deep soils with an adequate moisture supply can be used for the growing of meadow foxtail seed. As it develops slowly in the early stages, it is sown in spring and the early summer from April to June, without a cover crop, at 8 to 10 kg. per hectare in 50 to 60 cm. drills. Sowing by machine presents great difficulty, as the seed does not run well. It must, therefore, be mixed with several times the quantity of dry sand or sawdust. It is best to dibble in the seed by hand, but the field must previously acquire a fine, garden tilth. The rows are marked with a fork, which may be made to the right size by a smith, or with the drill machine, and the seeds are laid down by hand; with a little practice this work can be done comparatively quickly and ensures the seeds being sown regularly. Afterwards the field is harrowed with a light harrow and, when necessary, rolled. Weeds which appear must be eradicated early by machine and hand hoeing. Invading grasses must be dug out, as it is impossible to separate them from the meadow foxtail in cleaning. Special care must be taken to manure heavily. The seed ripens five to six weeks before the rye harvest, generally from the beginning to the middle of June. The crop should be harvested when the grains have assumed a brownish-grey colour and may be readily stripped from the ears. They fall out very easily if the ripening process has gone too far. A great drawback is the irregular ripening of the inflorescences; some are ripe when others are half-ripe, and others again still green. For



this reason it is best to carry out the harvesting in two parts. First, women are sent through the drills to strip the ripe ears. This seed is spread on the barn floor and dried by turning over several times a day. The remainder of the haulms are mown with a sickle, bound up in small sheaves, stooked in cocks and left to dry on the field. They are then carefully carried and immediately threshed. In this way little loss is incurred and good seed yield is obtained. The stubble and short grass is mown for hay. When the seed is thoroughly dry it is cleaned with a fan, the supply of air being carefully regulated so that no good, germinable seed is carried over into the chaff. For certification a purity of 80 per cent and a germination capacity of 75 per cent are required.

If the fields are hoed, drill-harrowed, harrowed and heavily manured every year twice after seed harvest and again in the early spring, they may be used for three or four years. Yield varies from 100 to 300 kg. per hectare. The average harvest per hectare at our seed-growing centres, obtained from crops sown in the spring without a cover crop was at follows :

| Harvest year | Number of seed-growing centres. | Seed kg. |
|--------------|---------------------------------|----------|
| 1st. ....    | 11                              | 212      |
| 2nd. ....    | 11                              | 242      |
| 3rd. ....    | 11                              | 125      |
| Mean :       |                                 | 193      |

A larger field sown down in 1923 at our experiment station produced :

| Harvest Year. | Seed kg. | Straw dz. |
|---------------|----------|-----------|
| 1st. ....     | 237      | 49.4      |
| 2nd. ....     | 311      | 53.1      |
| 3rd. ....     | 269      | 55.6      |
| 4th. ....     | 439      | 49.3      |
| 5th. ....     | 311      | 44.2      |
| 6th. ....     | 111      | 36.6      |
| Mean :        | 280      | 48.0      |

The seed production of meadow foxtail depends only upon the prices which may be obtained. If these are profitable, the growing of this seed will be greatly extended. The following German bred strains are available : the Weihestephan meadow foxtail (Bayer. Landessaatzuchtanstalt Weihestephan bei Freising, Oberbayern), K. v. Kameke's (Ostmärkische Saatbaugenossenschaft, Schwiebus). The greater part of Germany's imports comes from Finland, where meadow foxtail is collected by stripping from natural stands.

The principal pest of this grass is the minimum red or orange-yellow larvae of a gall midge (*Oligotrophus Alopecurii*), which is 1.5 to 1.8 mm. long and 0.6 mm. thick. It devours the florets and hibernates in the sterile fruit, developing again in spring when the seed is sown. The larvae is therefore seed-borne. Spikelets are also destroyed by *Thrips cerealium* and by ergot, so that they become sterile. Rust species (yellow and black rust) also attack haulms and leaves.

[From "Der Grassamenbau." (Grass seed production) by K. Weller. Arb. Reichsnährstandes No. 7. Berlin, 1936. pp. 68-70. *Herb. Abstr.* 6. 232. 1936.]







